OCTOBER/NOVEMBER 1995 ISSUE #50

Radio Fun

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"The beginners guide to the exciting world of amateur radio."

Sunspot Cycle 23 Begins (?)

Astronomers at the California Institute of Technology say they have identified the first new sunspot in the next sunspot cycle. Scientists at Caltech's Big Bear Solar Observatory in Big Bear City, California, photographed the spot on August 12. "This makes us happy," said Hal Zirin, professor of astrophysics at Caltech and director of the Big Bear facility. "The sun is a lot more interesting to study when things are going on." Early in the 11-year sunspot cycle, sunspots appear rarely and at relatively high solar latitudes around 30 to 35 degrees, then increase in frequency and appear at lower latitudes until they reach sunspot maximum, Caltech said. After this peak in activity, the number of sunspots slowly declines, and they appear ever closer to the sun's equator until they reach a relatively quiet phase called sunspot minimum.

The sun has been in a quiet period through much of 1994 and this year, with a few spots showing up near the equator. The new sunspot found on August 12 appeared at a solar latitude of 21 degrees, and its magnetic polarity is opposite to that seen over the last decade, a key to identifying it as "the manifestation" of the start of a new cycle, Caltech said.

Scientists at Caltech said they expected an early beginning to Cycle 23, but not this early. "Sunspots in the new cycle should rapidly become more common and reach a high level of activity in 1998 or 1999," Caltech said. *—ARRL Special Bulletin 46*

Cub Scouts Participate

Cub Scouts John Hixson and Anthony Berning making a contact from KCØWL (OH) with KC4MAI in Gary (VA) during the Boy Scout Jamboree On The Air.

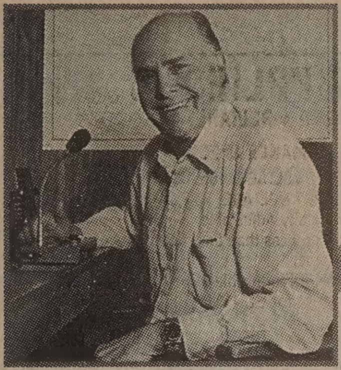
INTERNATIONAL LICENSE UPDATE

The Federal Communications Commission has assigned RM-8677 to an ARRL petition for rule making to implement U.S. participation in an International Amateur Radio Permit. A permit covering countries in the Western Hemisphere.

As previously reported, such a permit will allow temporary operation in any other country in the Americas that has signed the agreement. The only other requirement being that a person has to be a licensed ham in his or her home country.

The comment cutoff deadline on this matter is August 31st and the reply comment deadline is set for September 30th.

IN THIS ISSUE



Newcomers

by Wayne Green WNSD/1

Since *Radio Fun* is being sent to both regular subscribers and to new licensees, if you're a new ham, let me welcome you to what can be the love of your life. I got hooked almost 60 years ago and I'm still hooked. Since amateur radio is a whole bunch of hobbies, I recently made a list of every aspect that I could think of. I listed 53 branches of the hobby that I've been involved with, plus 20 more that I still have waiting for me. Somebody ought to offer a certificate.

No, I'm not monomaniacal about hamming. I have plenty of other interests. Tons. If you've read my editorials in my magazines down through the years you already know about some of my other interests. This is magazine number 28 that I've started, so I've written well over 1,000 editorials down through the years. If you've attended any of my talks, you know I'm enthusiastic about helping to solve some of our more serious political and social problems such as the lost drug war, crime, the ridiculous cost of our prison system, our terrible school system, and about ways to improve health care while cutting costs, and stuff like that.

I also love to travel, cook, scuba dive, and ski . . . and am into music big time.

I'm not into honors and titles, so I won't list any of that stuff. My ideas have to stand on their own, without a Ph.D. or other support.

My purpose in publishing *Radio Fun* is to do my best to get you interested in having a ball with this fabulous hobby. I'll be disappointed if you settle for talking about not much over some local repeater as the beginning and end of hamming. I want to get you up to at least an Advanced license so you can work the whole world. I also want to get you at least to try packet, slow-scan, ham-TV, and to build a few kits. Then I want to keep after you until you start going on some DXpeditions.

Yes, the code is a royal pain, but if you go about it the right way it's a snap. You can learn to copy 20 wpm from scratch in a few days. Or you can go the old route and spend agonizing months.

There's more. I need your help in getting more youngsters into the hobby. Thus I need you to brush up on your speaking techniques and get around to your local schools and give pep talks about how much fun hamming can be. We need to "poison" those little minds with an electronic bias. We need to foster radio clubs in our schools. Thousands of them.

> "My purpose in publishing *Radio Fun* is to do my best to get you interested in having a ball with this fabulous hobby."

I don't have a lot of space in *Radio Fun* to write at my usual length; so you're going to have to get *73* to get my longer editorials, where I go on at length about new technologies such as cold fusion. I also discuss interesting books I've read recently that you ought to know about. Sure, ham radio is fun, but it isn't everything. I also write quite a bit about health care and medical alternatives to the usual drug and cut approach.

For instance, I wrote over a year ago in *73* about a very simple gadget any ham could build in minutes that is being used to cure AIDS. It's worked for hundreds of otherwise doomed people, with no failures I've yet heard about. Further, it appears that it may also be effective for cancer and even trigger weight loss for the obese. Several entrepreneurs are building these gadgets for around $10 and selling 'em for a $100 as fast as they can make them. People don't think much about health until they get sick, and then they'll spend whatever it takes.

Most of us are busy slowly poisoning ourselves every day, not worrying about the future when the chickens come to roost. We do it with cigarettes, drugs, alcohol, food additives, Big Macs & fries, Danish & coffee, Aspartame, fluoride, chlorine, dental amalgam fillings, root canals, and so on. We do it with long-term exposure to magnetic fields. Then comes the heart attack, the stroke, cancer, and any of dozens of popular illnesses that our lifestyle causes. So we turn to our doctors for help. They're all set to treat your symptoms (but not the causes), knife and hypodermic needle in hand.

If you read many of my editorials, there will be times when you'll disagree with me. Surely Wayne is wrong this time! Hey, don't bet a lot on it. I read a ton of books, and talk with experts in just about every field I write about, so you'll find I've probably done my homework. I'm a "been there—done that" person. Look at my editorials from 10, 20, 30, 40 years ago, and you'll find that my record for calling the future is pretty good.

Some readers get the idea that because I occasionally criticize the ARRL that I hate the League. Nope. I've been a member for 57 years and I've always complained when they've screwed up, just as I berate the FCC when they do something stupid. I don't even hate K1MAN, though I sure do criticize him for lousing up our bands for so many hours every day.

Anyway, this is a sample of what we're doing to get your juices going. I hope you'll subscribe to *Radio Fun* and also to *73*. One of the more fun aspects of any hobby is buying new equipment; therefore, we have more new equipment reviews in *73* than in any other ham magazine. You can get a combo subscription to both magazines for $35 a year if you mention that Uncle Wayne said it was okay.

Letters

Write to: Radio Fun, 70 Route 202-N, Peterborough, NH 03458

Keith Raihala KBØMVC (Via the Warrensburg MO "The Repeater"). One thing worth mentioning are the high tech toilets in the public bath houses here in Japan. As you sit down, you feel like Captain Kirk of the Star Ship Enterprise getting ready to do battle with the Klingons. There is a control panel on the right side of the seat with several knobs and buttons. All the writing is in Japanese, so you don't know what is going to happen when you activate one. The big knob controls the temperature of the seat, which keeps you warm on those cold Misawa nights. When I pushed the first button, my backside was bathed with high-pressure hot water. When I jumped up off the seat in alarm, the water went half way to the ceiling. After I sat down again, I pushed the second button and was greeted with a blast of hot air that dried off my wet backside. Hey, this sure beats using the dryers on the wall in the American public bathrooms, and not as embarrassing. There was a third button, but I didn't push it because I couldn't handle what might have happened next. Maybe after I get over the trauma, I'll go back and check the other options.

I didn't think I was making so much noise during all this, but when I opened the door there were a bunch of people gathered around (to be described in a later letter). I found out what the third button did. As you are sitting there and you know you are going to do some serious blasting, you push the third button and it makes a loud flushing sound to cover up any embarrassing sounds. *Sure beats the bring-your-own-toilet-paper stinky holes in the floor they have in China. . . . Wayne.*

Rickey Nievera N2MBC. Newcomers to amateur radio might want to know about a way they can work DX via 2m. Talk about radio fun! I'm using an Alinco Data Radio with an old Amiga 2000 and the MFJ 1278B TNC with the MFJ 1290 Multicom software, and having fun with packet as I work DX via the Internet. Here's what I do. I connect first to a local node and then to an Internet Gateway like N2MH-11, which is more than 50 miles away. At the prompt I'm on the Internet. I type "/Who," and a long list of DX stations are listed, including a couple from Australia! It can take a long time to get through on the busier nodes, but since there are a lot of channels, you can move off for a private contact. Digital modes are here! RF

Radio Fun

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Communications Simplified, Part 2

by Peter A. Stark K2OAW

After our introduction to sound and audio in the first part, we now continue with pictures and video.

Video

You can send pictures through communications in various ways, but the most common means today are fax machines and television. So let's talk about those.

Fax Machines

Twenty years ago, fax machines were very rare, though not entirely unknown. Currently, almost every office has at least one fax machine.

Today's fax machine can send letters, pictures, cartoons, photos, and almost anything that you can feed through its slot. Shown in Figure 1, the typical machine consists of five parts: (1) a scanner that can scan a printed page and convert it into an electrical signal; (2) a printer that can take such an electrical signal and print it on paper; (3) a telephone and dial by which to call other machines; (4) a modem that couples the digital circuitry to the telephone line; and (5) a microprocessor that ties it all together and makes it work.

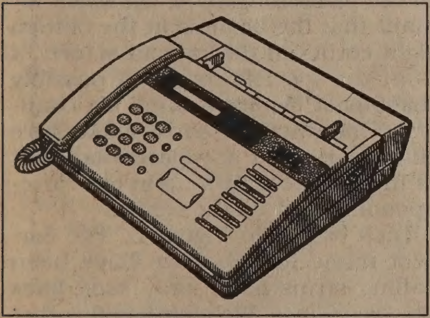

Figure 1. A typical fax machine.

Since the fax machine contains both a scanner and a printer, it can usually be used as a copier; that is, it can scan one piece of paper, and at the same time create a copy of it in the printer. But that's a secondary function. Its main purpose is to transmit that page through the phone to another machine.

To begin the process, you insert the page you want to send into a slot on the fax machine (the slot is on top of the machine illustrated), pick up the handset, dial the number of the machine you want to reach, and wait for the call to go through.

When the called machine answers, it sends back some tones whose purpose is to let your machine know that the connection has been made. When you hear these, you generally press a START button, hang up the handset, and wait for the call to finish.

Let's skip ahead to this point, and look at how your fax machine scans the page you want to send. Figure 2 shows an enlarged view of some typewritten text that we want to send.

When you push the START button, a photosensitive scanner head starts to sweep across your page, from left to right, starting at the upper left corner. The small arrow at the top left of Figure 2 shows where the scanner starts and the direction in which it moves. It never sees your entire text; rather only the narrow area of white and black over which it passes. The scanner sees only the tops of the letters "th" and the top of the dot over the "i" (as well as the tops of the two "h"s farther on the right), since all the other letters are shorter. As it scans from left to right, it sees the dark areas shown in Figure 3.

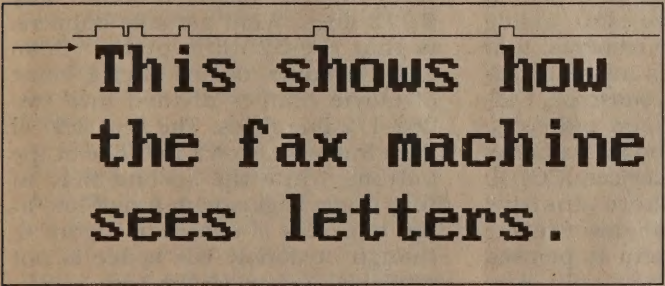

Figure 2. Enlarged view of some text being sent.

This is an important concept to understand: The fax machine doesn't actually try to read the letters themselves. It only looks at the patterns of white and black. In other words, your page could contain English, Chinese, or Russian letters, drawings, or chicken scratchings. Only the patterns of light and dark are sent.

As the scanner goes across the page, it outputs a waveform like that shown at the top of Figure 2. This is a digital signal that shows a low value of voltage when the scanner is passing over white paper, and a higher voltage when it passes over black ink. Although more expensive fax machines can handle grays, the typical cheap fax machine doesn't sense differences in grays. If a gray is light, it's treated as if it is white; and if it's dark, then it's assumed to be black.

As the scanner head is moving right, its output is sent to the microprocessor as a digital signal. When the head reaches the right margin, the microprocessor goes to work; meanwhile, the head returns back to the left and the paper moves up about 0.005 inch. Eventually (after the microprocessor has finished processing this signal), the head will start another sweep across the page, but this time about 0.005 inch lower down on the paper. It will then scan another strip of text, and so on, until it eventually reaches the bottom of the page. In this way, the 11-inch height of the paper is divided into about 2200 strips, each about 1/200 of an inch high (that's 0.005 inch), and each strip is scanned for light and dark areas across the width of the paper.

But let's return to the microprocessor, which gets the signal shown at the top of Figure 2. This signal has only two voltage levels (assuming we're dealing with an inexpensive black-and-white fax machine). A digital signal like this can't

Figure 3. What the fax scanner sees.

be directly sent through the telephone line; besides, it would be inefficient to do so. And so the microprocessor analyzes the signal and sends a *description* of the signal, rather than the signal itself.

The microprocessor measures distance on the paper in *pixels* rather than inches; each pixel being 0.005 inch. (A typical fax machine actually has a fine mode and a coarse mode, depending on the sharpness and detail you want. I am using the numbers for fine mode in this description.) The word pixel is an abbreviation for *picture element*, and it is the smallest spot that the fax machine can see or print. If you look at the printout in Figure 2, you can see that the letters look as though they are made out of square blocks; these are the pixels. The 8.5-inch width of the paper is therefore about 1700 pixels wide.

As the microprocessor receives the signal from the scanner head, it counts off the number of pixels of white and black, and generates a description of the signal in terms of pixels. For example, if it sees an entirely blank sheet of paper, it simply sends a message to the other machine that there are 1700 white pixels. On the other hand, if there is a lot of printing on that line, the description might read:

- 10 white pixels
- 3 black pixels
- 17 white pixels
- 7 black pixels
- 12 white pixels
- 9 black pixels, etc.

You can see that the description of a blank line is a lot shorter than the description of a line with a lot of print. Hence, how long it takes to send a page depends on how much writing is on it. A blank page might feed through in 10 or 15 seconds, an average letter might take 30 seconds, or a page of newsprint might take almost 2 minutes. You can notice the difference as you watch the machine send or receive a page. Blank or nearly blank pages feed through at a speedy clip; complex pages feed through in tiny spurts.

The advantage of sending descriptions rather than the actual waveform is that *for an average page* this takes less time than would sending the actual waveform.

At this point, it doesn't pay to delve much deeper into the fax machine, since my primary purpose in discussing fax machines is to lead into a discussion of TV; let's just say that the description coming out of the microprocessor is itself a digital message. Since the telephone line is not able to carry digital data directly, a *modem* converts the digital data into tones that are then transmitted through the line. The word modem stands for *mo*dulator/*dem*odulator, the device that converts (modulates) data to tones on one end, and then changes (demodulates) the tones back to digital data at the other end.

Before moving on to TV, let's just summarize: The fax machine divides the printed page into horizontal strips about 0.005 inch high (and therefore about 2200 strips per 11-inch page), and scans each strip from left to right. The black/white information from each strip is sent from the sending machine to the receiving machine, but as a description rather than as the data itself. It takes anywhere from 10 seconds to perhaps 2 minutes to send a page, depending on its complexity, which means that the time to send the information for one strip takes anywhere from 10/2200 second (about 0.005 second) for a near-blank page, up to about 120/2200 second (about 0.06 second) for a fairly complicated page. In terms of what we learned about bandwidth in Part 1, it takes a fairly long time to send the picture and therefore not much bandwidth is needed.

Television

Let's summarize normal TV in terms similar to what we just did for fax machines. The TV camera divides a picture into 525 nearly-horizontal strips (the height of the strip depends on the size of your TV screen), and scans each from left to right. The information, which includes not just black and white but also grays and colors, is sent as the actual waveform, not as a description. Regardless of how complex, light, or dark the picture is, it takes the same 1/30 of a second to send that waveform. Furthermore, in order to provide the feeling of motion, the TV camera sends 30 complete pictures per second. As you can guess, the bandwidth for a TV signal must be much higher than that of the fax signal.

Let's look first at what the TV camera does. Figure 4 shows how a lens focuses an image of a person onto a photosensitive plate inside the camera. In studio cameras, that photosensitive plate is inside a vacuum tube called an *iconoscope*. Older home cameras used *vidicons*, whereas the latest home cameras use charge-coupled devices (CCDs). Either way, the photosensitive screen gets an upside-down image of whatever the camera is pointed at. This image is then split into strips and scanned.

In an iconoscope or vidicon, that scanning is done by a thin electron beam, which is aimed at the screen; in the CCD, the screen is itself divided into tiny spots, each of which can measure the amount of light hitting it, and electronic circuitry then interrogates each spot to see how much light it got. Since the studio cameras use iconoscopes, I will talk about the beam as doing the scanning.

As in the fax machine, scanning is done from left to right, and top to bottom of the picture. But since the picture in the TV camera is upside down, in the camera it starts at the bottom right, and goes from right to left, and bottom to top, as shown in Figure 5.

You'll note that, unlike in the fax machine, the strips in the TV camera are not exactly horizontal. There is a very slight tilt to them, because as the scanning goes from side to side, it is also moving upward, although much more slowly. You can also see a thin line, called a *retrace* line, which shows how the beam jumps from the end of one line to the beginning of the next.

Figure 5 also shows the beam as it moves in the picture tube in your home TV receiver. Here again, you will note that there is a slight tilt to the lines,. but here the scanning starts at the top left, and so the beam moves slightly down as it moves right. What is impressive about the whole setup is that the beam in the camera is exactly synchronized with the beam in not just your TV set, but also the beam in every single other set that is tuned to the same station. At the exact instant that the beam is at the bottom right corner of the camera screen, it is at the top left corner of possibly millions of TV sets around the country. This must be so to make sure that an item in any particular spot of the picture shows up in the corresponding spot on the screen!

Let's return to Figure 5. The correct name for what we have been calling strips is actually *scan lines* or *sweep lines*. We mentioned earlier that there are 525 strips in the picture, whereas Figure 5 shows only 6-1/2 lines. What actually happens is that the 525-line picture (also called a frame, named after a frame of movie film) is divided into two 262-1/2-line fields. The first field of each frame ends on a half-line at the bottom, while the second field of that frame begins with a half-line at the top. This is shown in Figure 6, though obviously the space is not available to show all the lines.

You will note how neatly the lines

of field 2 fit between those of field 1. This process is called *interlacing*, so that a normal TV picture is said to be *interlaced*.

To understand why interlacing is needed, let's consider movie film. In order to show motion on the screen, the movie projector projects a series of slightly different frames on the screen, at the rate of 24 frames per second. But if the projector lit up the screen just 24 times each second, most of us would be badly annoyed by the flicker. So the projector actually puts each frame on the screen twice, for a total of 48 "flashes" per second.

Television has a similar problem. It transmits 30 complete frames per second, but to avoid flicker has to light up the screen more often than that. It is not really practical to flash each frame on the screen twice, because then either the TV transmitter would have to send each frame twice (which would require more bandwidth) or else the TV set would have to store each frame in an internal memory so it could display it a second time (which wasn't practical decades ago when TV was designed.) So television was designed to transmit each frame in two halves—the two fields, with 60 fields per second.

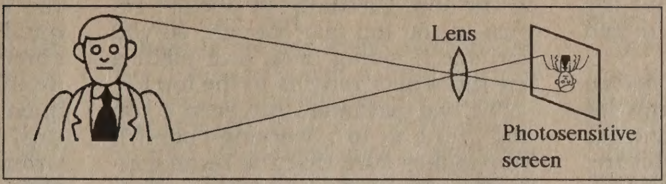

Figure 4. A simplified black-and-white TV camera.

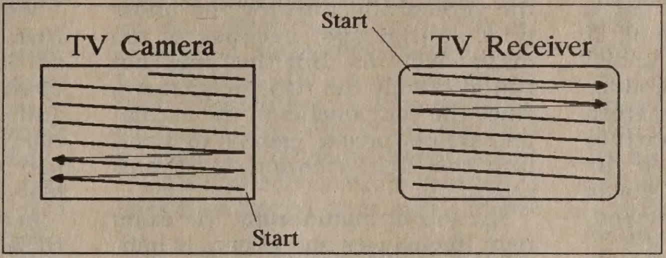

Figure 5. Scanning in the camera and receiver.

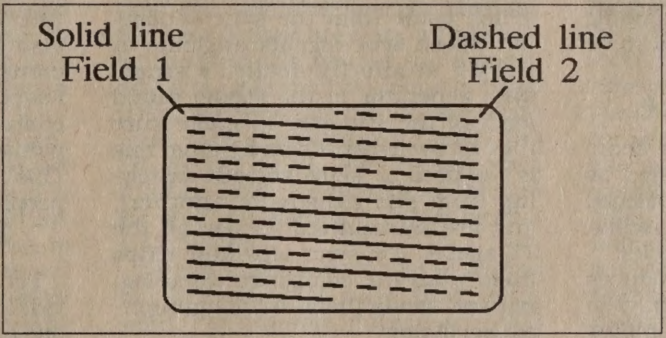

Figure 6. Two fields make a frame.

Note that storage of frames was not practical years ago, but the prices of memory circuits have dropped to the point where it now is. Most computer monitors (which work on the same principles as those of a TV set), therefore, do not use interlacing.

So let's put some of the numbers back together:

• There are 30 frames per second. (In a color picture, there are 29.97 frames per second, or 0.1% less.)

• There are 60 fields per second (or 59.94 fields per second in color). This means that the electron beam moves up and down 60 times per second in the picture tube.

• Each frame contains 525 interlaced lines, or 262-1/2 lines per field.

• The 525 lines of a frame repeat 30 times per second, so there is a total of 525 X 30, or 15,750, lines per second. Thus the electron beam moves left-right a total of 15,750 times per second (which drops slightly to 15734.25 with color.).

Remember that the beam motion must be completely synchronized between the camera and all TV receivers watching that channel to make sure that all objects appear in the right place on the screen. Making all of these beams move together requires that the beam motion circuitry in every TV set is synchronized with the camera. Let's look at Figure 7, which is a very simplified block diagram of a typical black-and-white TV set.

The signal coming in from the antenna goes through a box labeled "Tuner, etc." There is actually a lot of circuitry in this box; however, because we're not nearly ready to discuss it, let's just say that this is where the signal is amplified, and the particular channel is selected. The signal then goes into the video detector, whose output is a signal called *composite video*. This signal is in turn sent to the sync separator, which separates the composite signal into three parts: video, horizontal sync, and vertical sync.

The video signal contains the actual picture information, including whether a particular pixel should be light or dark; it also tells what color that pixel should be, except that we are limiting ourselves to a black-and-white TV for now. This signal is amplified by a video amplifier and sent to the picture tube.

Meanwhile, a beam of electrons travels from the electron gun to a layer of phosphor material on the screen. Whenever the electron beam hits the screen, the phosphor material lights up to produce a visible spot. You can vary the brightness of that spot by changing the strength of the beam; that in turn is controlled by the video signal from the video amplifier.

DETOUR 1

We've been avoiding discussing color for a while, but since we have to cover it eventually, here goes.

In a color set, there are three video amplifiers and three electron beams in the tube, one for each of the three colors (red, green, and blue.) There are also three color phosphors on the screen, with a "shadow mask" behind the screen

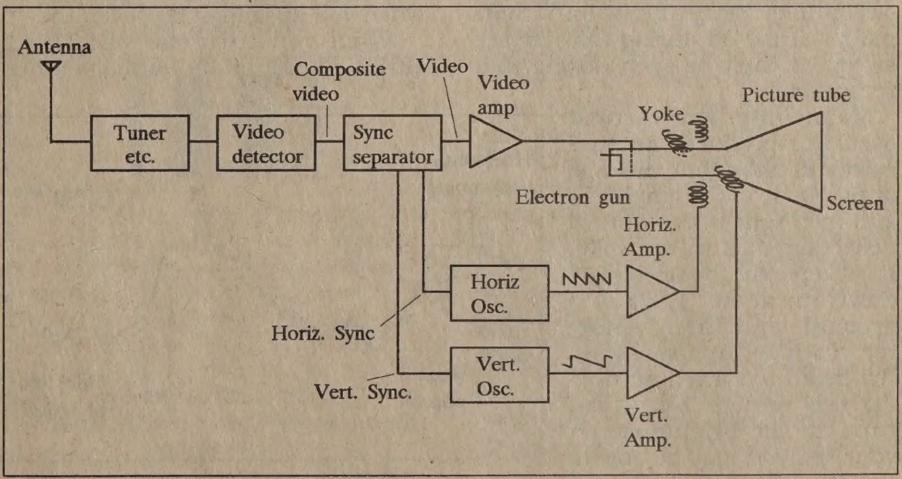

Figure 7. Black-and-white TV block diagram.

that masks the screen so that the red beam can reach only the red phosphor, and so on.

If you look at a color set's screen with a magnifying glass, you can see the tiny color dots (or sometimes stripes) that make up the picture. But if you lean back, the tiny color dots blend together into other colors. For example, when a red dot, a green dot, and a blue dot are all lit up next to each other, from a distance their colors add up to produce a white dot. A red dot and a green dot together, without blue, produce yellow. The various colors on the screen are thus put together out of various combinations of tiny red, green, and blue dots.

Normally, all three electron beams move across the screen together, but their intensity varies depending on what the color is supposed to be at that point.

END OF DETOUR 1

The motion of the electron beam (or beams in color) is controlled by the horizontal and vertical *deflection circuits*, which consist of two oscillators, two amplifiers, and the *yoke*.

The horizontal oscillator produces a sawtooth wave at a frequency of 15,750 Hz. This signal is amplified by the horizontal amplifier, and sent to a pair of coils in the yoke. The yoke looks like a doughnut-shaped ring that is slipped over the neck of the picture tube. It contains four coils that produce a magnetic field as current flows through them. Two coils, positioned above and below the neck, move the beam left and right, while the other two move it up and down.

The sawtooth horizontal sweep signal is sent to the two horizontal deflection coils in the yoke. The sawtooth voltage sweeps the beam from left to right, and then suddenly swings it back to the left (the retrace) in preparation for the next sweep line. Since the beam is normally turned off during that retrace sweep, it can't be seen during that return trip.

Meanwhile, the vertical oscillator produces another sawtooth wave, but this one at 60 Hz. It too is amplified, and then sent to the vertical deflection coils in the yoke. It sweeps the beam slowly down (in about 1/60 of a second), and then rapidly returns it to the top. Again, the beam is turned off during this retrace, but if you turn up the brightness on your set, you may be able to see the beam as it returns to the top. (Actually, it doesn't return to the top fast enough, so you can see it swing back and forth a few times as it returns to the top.)

The two oscillators run even if you don't tune in to a working channel. This makes sure that the beam continues sweeping across the screen, rather than settling in the middle of the screen and burning the phosphor at that spot because of too many electrons. But they may not run at exactly the right frequencies, since the components in the oscillators are not precise enough to maintain the right frequencies themselves.

The job of maintaining the exact right frequencies and phases is handled by the horizontal and vertical synchronization (sync) signals, which come from the sync separator. These sync signals originate at the TV studio (typically, a single sync generator in the studio would feed all the cameras to make sure they all sweep at the same time; this is required to allow smooth switching from one camera to another), and are transmitted as part of the TV signal. The sync separator strips them from the composite video signal and sends them to the appropriate oscillator.

DETOUR 2

In the absence of the sync signals—for instance, when you're not tuned to a working channel—the vertical and horizontal oscillators "free-run," meaning that they oscillate without being synchronized to a station. If the free-running frequency is not close enough to the frequencies required by the station, however, the sync pulses may not be able to synchronize them. Hence, most TV sets have a pair of controls, called VERTICAL HOLD and HORIZONTAL HOLD, which bring the free-running frequency into range. You may have noticed what happens when you misadjust these controls.

When you turn the VERTICAL HOLD control off its normal setting, the vertical oscillator's normal frequency varies out of range of synchronization, and the oscillator suddenly oscillates at the wrong frequency. When this happens, the vertical position of the picture will be wrong, and it may roll up or down, depending on which way the control is set.

When you turn the HORIZONTAL HOLD control away from its normal setting, the horizontal oscillator changes to a different frequency, and parts of the picture move left or right. This normally slides the picture sideways and then suddenly tears the picture into diagonal bars.

In addition to VERTICAL SIZE and HORIZONTAL SIZE controls (which vary the gain of the vertical and horizontal amplifiers to make the picture larger or smaller), many TV sets also have a VERTICAL LINEARITY control. This control changes the shape of the sawtooth vertical sweep control, and results in the top of the picture stretching or shrinking a bit. This control is normally set to make people's heads appear the right size.

END OF DETOUR 2

Let's return now to the composite video signal, the signal that comes out of the video detector in Figure 7 to the sync separator.

If you look at the composite video signal with an oscilloscope, you see a signal that looks something like Figure 8.

Figure 8 shows three horizontal sync pulses, each separated by 1/17,500 second, the time for one horizontal line. Each of the pulses sits on top of a *pedestal*, which consists of a *front porch* and a *back porch*. The jagged line between any two horizontal sync pulses represents the video signal for one sweep line. As this figure shows, two consecutive sweep lines are generally somewhat similar to each other, though not identical, because they are essentially almost-adjacent strips of the same picture. (I say "almost adjacent," because they are separated by one strip of the interlaced second field.)

The voltage of the video information represents the brightness (also called the luminance) of the picture. In Figure 8, black is up, near the sync pulses, while white is down, and there are various shades of gray between. This polarity makes the most sense when we talk about a pedestal; keep in mind, though, that most transistor amplifiers invert their signal; thus, de-

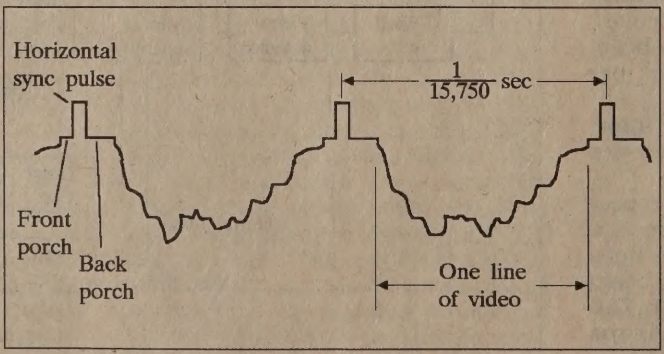

Figure 8. Composite video signal.

pending on where you connect the oscilloscope, the signal may be either as shown in Fig. 8, or upside down (with the sync pulses pointed down, and white being up). For example, the standard output of a VCR's or camcorder's VIDEO OUT jack is an upside-down signal, with the tips of the sync pulses being down at 0 volts, and the white peaks of the video signal at approximately +1 volt.

A vertical sync pulse occurs once every 262-1/2 horizontal sync pulses. The shape of this sync pulse depends on the circuit that generates it. In commercial TV, it looks like a half-dozen horizontal sync pulses strung together, with some extra short pulses before and after them; this is often called a *serrated* sync pulse (like the serrations in a steak knife). In computer monitors (which are usually not interlaced and in which timing is not as crucial), the vertical sync pulse is often just a single, but very long, pulse.

The pedestal looks somewhat different in a color signal, because the back porch contains nine cycles of a 3.579545-MHz signal called the *color burst*. The color information is carried on a 3.579545-MHz "subcarrier" (we will define that word later) and the color burst is used to synchronize a color oscillator in the TV set. (If you've seen cheap 3.579545-MHz crystals in the Radio Shack catalog, now you know where that crystal is used.)

Bandwidth

Let's return to the question of bandwidth of a TV signal. Suppose we aim a TV camera at a black sheet of paper containing a thick, vertical white bar, and look at the resulting composite video signal; we will see something like Figure 9.

The top of Figure 9 shows the screen, while the bottom shows one line of the composite video signal. Since the picture is identical from top to bottom, all the scan lines will look the same.

What we now want to ask is this: What is the spectrum of the composite video signal?

With some fancy mathematical analysis, we could come up with an exact answer. But we needn't go that far if we're willing to accept an approximate answer instead of the exact numbers. Looking at the video signal, we see a signal that, except for the horizontal sync pulse, would look like some sort of a square wave. Its frequency is 15,750 Hz, the same as the frequency of the sync pulses. Since the sync pulse is relatively small compared with the rest of the wave, ignoring it will produce an error in our answer, but not a tremendously large one.

But we already know what makes up a square wave: a fundamental plus odd harmonics. Hence, this signal consists of a 15,750-Hz fundamental, plus harmonics at multiples of 15,750 Hz (but, since the signal is not exactly a square wave, there will also be even harmonics). There will (at least theoretically) be an infinite number of harmonics; however, after the first 100 or so harmonics, their amplitudes will be so small compared with everything else that we might as well forget about them.

Let's now increase the number of bars from one to three, as in Figure 10.

As before, we can again approximate this signal with a square wave (and even more accurately, because the sync pulses are now even smaller than all the rest of the signal), but this time the frequency is three times higher than before. A square wave with a frequency of 3 x 15,750 Hz, or 47,250 Hz, now consists of a fundamental frequency of 47,250 Hz, and odd harmonics starting at 3 x 47,250 Hz.

In the same way, we could extend our process to as many bars as we want. For example, if there were 300 vertical bars on the screen, then the fundamental frequency of the square wave would be 300 x 15,750 Hz or 4.725 MHz, and the harmonics would start at approximately 14 MHz.

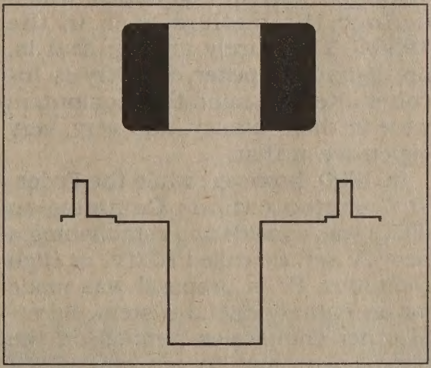

Figure 9. A TV picture with one white bar.

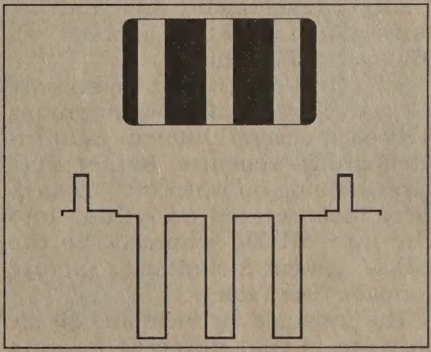

Figure 10. A TV picture with three white bars.

There is only one problem with this idea. If you look at Figure 2, you see that the received TV signal has to go through the box labeled "Tuner etc." And this part of the TV set generally has a maximum bandwidth of about 4 MHz (depending on the set, with color sets being somewhat worse than black-and-white sets.) In other words, our TV picture with 300 vertical bars will not get through that part of the set because even the fundamental frequency, the lowest frequency in the video signal, lies above 4 MHz!

Even a picture with just 100 bars would have some difficulty. Its fundamental frequency of 1.575 MHz would make it, but even the lowest harmonic, at 4.725 MHz, would not. In other words, the square wave video signal would be reduced to a sine wave. As a result, the signal would gradually change from white to black, or from black to white; on the screen, the edges of the bars would appear blurred.

The bandpass of the "Tuner, etc." part of the TV set puts, therefore, a basic limit on the number of vertical bars we can display, sharply or not. This limit varies with the set, but is about 250 lines. We call this the horizontal *resolution* of the TV picture.

It happens that the vertical resolution of a TV set is also about 250 lines. Of the 525 sweep lines on the screen, a bit under 500 actually appear on the screen (the others are either above or below the border of the screen, or else occur while the beam is returning from the bottom back to the top). If these 500 or so lines alternated between one white, the next black, and so on, then the maximum we could get would be about 250 white lines separated by 250 black lines.

It *is* possible to get somewhat better than 250 lines of horizontal resolution on a TV screen, but only by bypassing the "Tuner, etc." portion of the TV set. Many TV sets permit that by having a composite video input jack, or even better, separate connectors for video and sync signals. Many camcorders, VCRs, and laser disks offer better than 4 MHz bandpass, and can therefore provide a sharper image, but only when they are connected directly to these special video input jacks.

Bandwidth thus affects not just the sharpness or resolution of the TV picture, but also the speed at which TV pictures can be sent. The number of lines could be increased

either by increasing the bandwidth or by slowing down the transmission so that the entire horizontal line would take longer. For example, the fax machine achieves much greater horizontal resolution at a lower bandwidth by taking more than 1000 times as long to send one line of video.

Or consider TV pictures sent back from a spaceship to Jupiter. Since a wide-bandwidth signal picks up much more noise, space TV signals are sent at a very low bandwidth to minimize this noise. As a result, they must be sent very slowly to maintain any reasonably good resolution. It often takes several minutes to get one picture.

Color TV

When color TV first started, there were very few color receivers, and very few stations transmitting color. So color TV was originally designed to be completely compatible to make sure that customers with black-and-white sets could receive the color stations, and vice versa.

In color TV, everything happens exactly 0.1% slower; there are 29.97 frames per second instead of 30, and the horizontal frequency is 15,734.25 Hz instead of 15,750 Hz. So the composite video signal consists of 15,734.25 Hz and its harmonics.

Let's take a look at two specific harmonics: the 227th harmonic (at 227 x 15,734.25, or 3,571,674.75 Hz) and the 228th (at 228 x 15,734.25, or 3,587,409 Hz). Neatly sandwiched between those, at 3.579,545 MHz, safely out of the way so it won't interfere with either harmonic, is an added signal called the *color subcarrier*. This is a weak signal, carried as part of the color composite video signal, whose phase at any instant tells the color TV set what color to make the screen at that instant. (A modern black-and-white TV ignores this signal, though early sets used to display a tiny herringbone pattern on the screen when watching a color signal.)

frames/sec	scan lines	resolution (lines)	Interlaced
60	720	640	no
24	720	640	no
30	720	640	no
30	1080	960	yes
24	1080	960	no
60	1080	960	no

Table 1.

We've already mentioned the color burst signal, a short burst of 3.579545 MHz that sits on the back porch, just after the horizontal sync signal. The color set has an internal 3.579545 MHz oscillator; the color burst synchronizes this oscillator so it is in phase with a master color oscillator in the TV studio. To decide on the exact color to put on the screen, the set compares the phase of this local oscillator with the color subcarrier.

Digital TV

The method we've described up until now is called the NTSC method, named after the National Television System Committee, which defined the method back in the 1950s. It is purely analog; that is, no digital computer circuitry is involved. Keep in mind that computers were in their infancy, and very, very expensive at that.

In 1990, however, while the Federal Communications Commission (FCC) was considering establishing a new TV service called HDTV, or High Definition TV, a proposal was made for an entirely digital system. Several other companies jumped on the bandwagon, and the current HDTV system design comes from a group called the "Grand Alliance": AT&T, General Instrument, MIT, Philips, Sarnoff (the old RCA Laboratories), Thomson, and Zenith.

The Grand Alliance team was formed after several different groups proposed several different (and incompatible) schemes. Rather than give anything up when they merged, they incorporated everything into the final HDTV proposal. So the HDTV system includes six picture formats. (See Table 1.)

The rationale for including all six formats is that different formats could be used for different types of programs. For example, movies (which run at 24 frames per second) would not have to be converted to 30 frames per second, as happens now.

The HDTV system also includes five channels of sound for stereo and surround sound, and even provisions for extra data channels for sending computer data.

If all of this were done with analog methods, the bandwidth would be much larger than current NTSC television, which would mean a reduction in the number of TV stations allowed. But sending the pictures digitally allows digital compression methods to be used. For example, since two consecutive picture frames tend to be very similar, TV stations could transmit just the differences between them. The digital circuitry in the receiver would then insert the changes into the preceding frame, stored in digital memory, to make the new frame.

As a result, the complete HDTV picture would fit into the same channel format as current TV. Although you would need a new (and much more expensive) TV set to receive HDTV, there would be a period of transition when both NTSC and HDTV stations would transmit at the same time. The hope is to be able to sandwich HDTV signals into the unused channels between current NTSC stations, without causing interference in either direction.

One interesting aspect of HDTV is that, although it is very different from NTSC, it has been purposely designed to be compatible with computer applications. The idea is that the same HDTV sets could also be computer monitors. Since the digital transmission method used for HDTV can accommodate digital data as well, there is an underlying hope that television and computers will merge into the ultimate tool for the "information superhighway" of the future.

Summary

Although this part has just been a limited introduction to television, it has covered several important concepts. Aside from an idea of how TV works in general, we have once again seen the impact of bandwidth on the transmission of information, and also once again seen the interaction between bandwidth and time. Although we haven't provided any definite proof (that would require some advanced math concepts), we still begin to see that bandwidth is a necessary part of communications. If a signal has no bandwidth, then it cannot transmit any information at all. RF

Try It Before You Use It

by James Melton

If you are a seasoned electronics pro, you can probably look at a data sheet for a particular chip and understand how it works, how to use it, and what its limitations are. Most of the rest of us, however, could benefit from a little hands-on experience with the new chip.

"Breadboarding" is the term used to describe building a circuit that either is temporary in nature or is a one-of-a-kind prototype. In the old days many experimenters used actual breadboards, or built circuits on flat boards that resembled them. In this day and age, however, the circuit components have leads that are simply too closely spaced for convenient testing or experimenting. The modern breadboard consists of a surface with hundreds or thousands of holes, spaced on 0.1-inch centers, designed to help you make connections between the pins of ICs and various other components. The IC is pressed into the holes, power and ground connections are made, and the input and output lines are connected. The input leads are moved to either the high buss or the low buss, and the output lines are monitored to verify or find out how they respond to various inputs.

Breadboarding also requires a power supply for the chips. In many cases +5 volts (for all TTL circuits) or +12 volts (for CMOS chips) is required. Analog circuits (such as op-amps) usually require a balanced +12 and -12 volts.

Now I'll tell you how you can build your own breadboard setup for a fraction of the price of a commercially made model.

The Design

As you can see in Figure 1, the circuit for the power supply consists of a transformer to reduce the 120-volt line voltage to a more manageable 24 volts, center tapped. The center tap allows you to develop both positive and negative voltages from one transformer. Using the center tap as system ground, CR1 and CR2 form a full-wave positive bridge, and CR3 and CR4 form a full-wave negative bridge.

C1 and C2 are both 50-volt 50 µF electrolytic capacitors that filter the pulsating DC from the positive rectifiers. Together they are equivalent to one 50-volt 100 µF capacitor; I used two caps because that is what I had on hand. C3 and C4 form the negative filter.

The voltage developed after the filter capacitors is about 18–20 volts. You must use a regulator to bring the voltage down to a steady, dependable voltage. In the case of TTL logic circuits, the voltage must be between 4.75 and 5.25 volts. A 7805 series pass regulator is used to lower the voltage for the 5-volt supply. If you use enough heat sink, this three-terminal regulator is capable of passing up to 1.5 amps of current. But if you draw too much current, the regulator has built-in protection circuitry to shut it down. Note on the schematic that there is a 0.1 µF capacitor (C6) between the output pin of the regulator and ground. Although you may be tempted to omit this part due to its rather low value, don't leave it out. It's there to shunt the high-frequency noise that the 7805 can develop to ground. If you leave it out, you might not discover the noise exists until late some night when you have been troubleshooting what you

Photo A. Pretty simple, eh? A one-evening project.

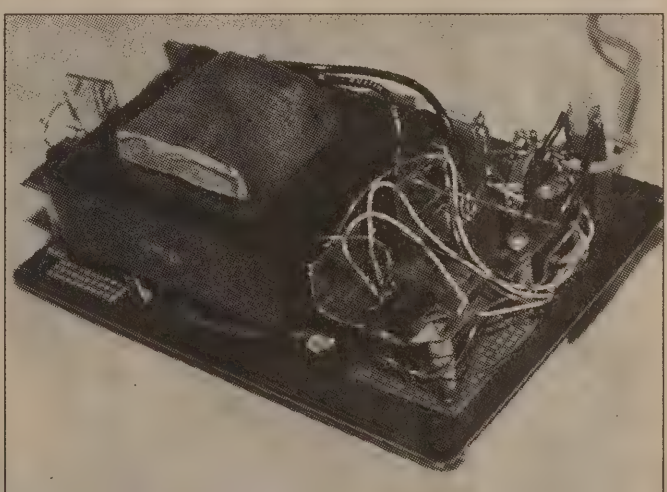

Photo B. Note the home-made heat sinks, bent to fit the space available. Everything is built into the lid of the box.

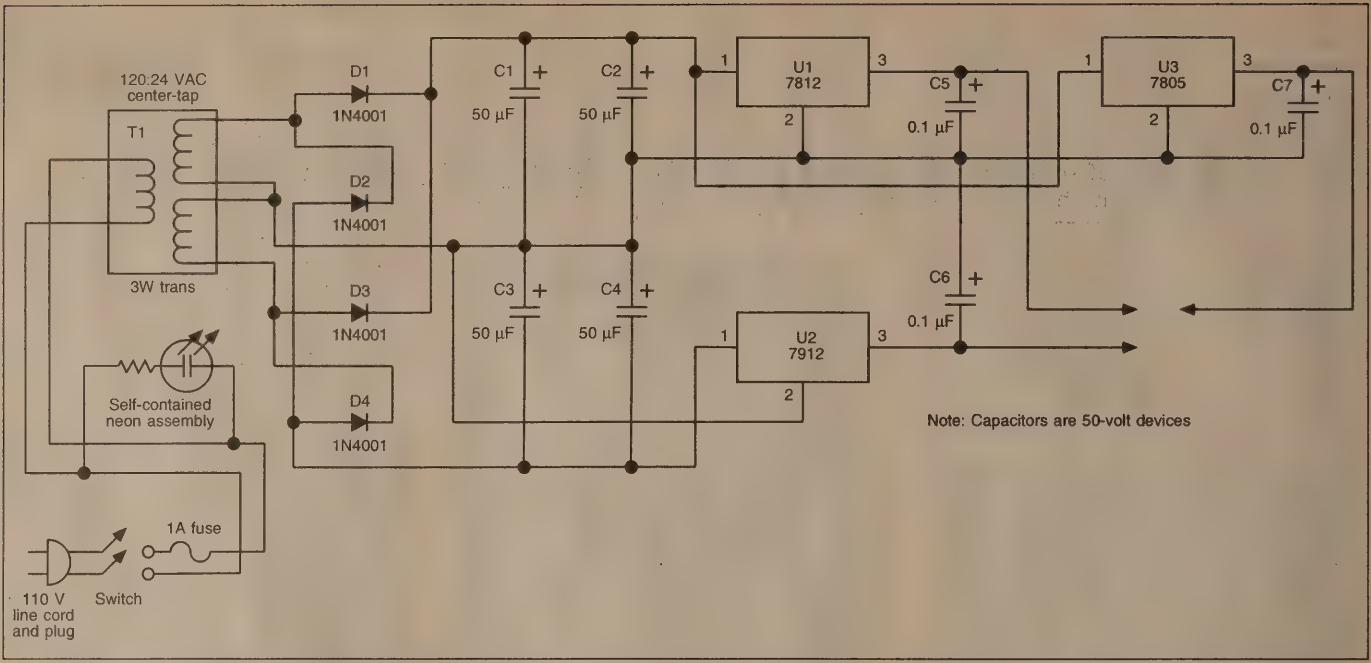

Figure 1. Schematic of the breadboard power supply. We're talking a dirt-simple circuit. Great beginner's project.

thought was a simple circuit. Because noise can give you trouble, try to get rid of it.

The 12-volt supply is regulated just like the 5-volt supply with a 7812. The same rules and features apply to this chip. It'll handle up to 1.5 amps if adequately heat-sunk. Put C5, the small output capacitor, as close to the output pins as possible.

As you might imagine, the negative supply is the same as the other two. Same type of regulator (the negative series begins with "79") and same rules regarding electrical limits, but a slightly different arrangement for input, ground, and output leads. See Figure 2 for the pictorial of the input and output leads on the 78xx and 79xx series of regulators.

Construction

Since the transformer is the heaviest part, I put it in the center. Photo A shows the general layout of the parts I used. If you prefer the power supply binding posts to be on the side rather than the top, go ahead. Photo B depicts the heat sinks I used. Since I was trying to make the unit as small as possible, I had to make the heat sinks from scrap material. The pieces of aluminum I used were bent to make the most of the available space.

The wiring for the regulators was done with a combination of wire wrap and point to point. The bypass capacitors are mounted directly to the output posts of the box. One note: Although many electronic designers are tempted to put large-value capacitors on the

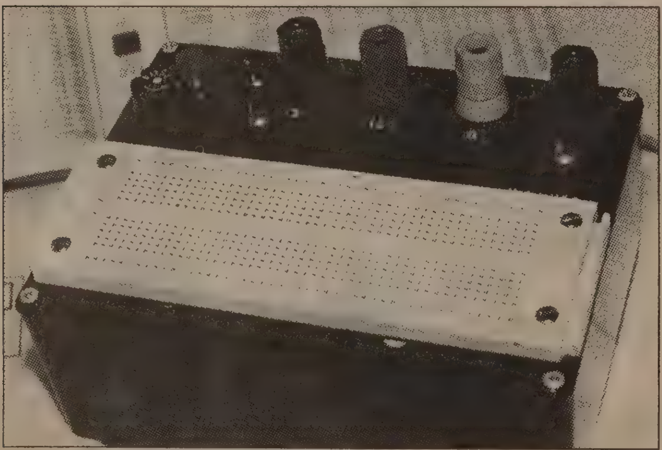

Photo C. The whole works are built into a small equipment box.

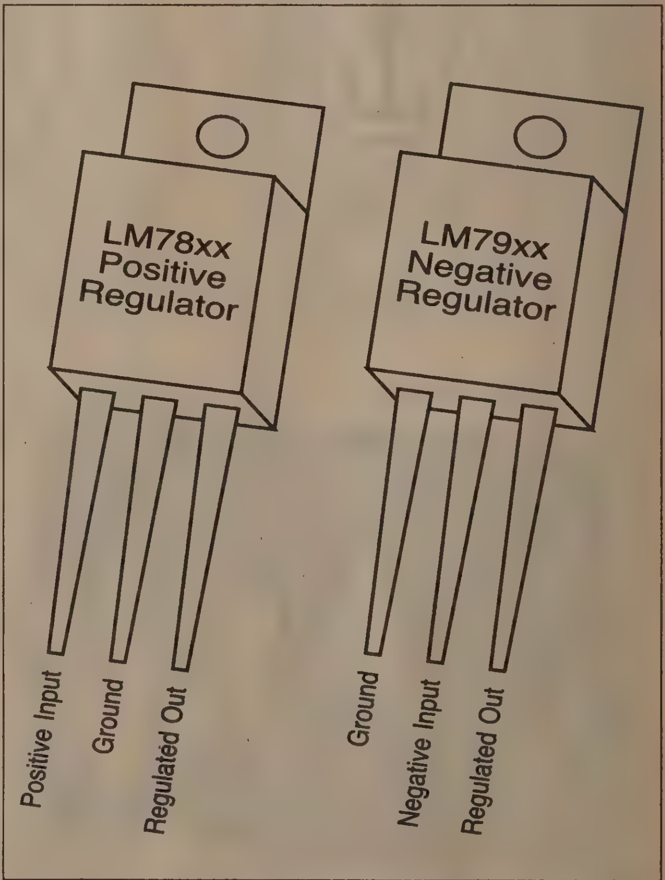

Figure 2. This is a pictorial of the input/output and ground leads of the 78xx/79xx series pass regulators.

output of regulators, this is not necessary; in fact, it can put needless strain on the devices when first powered up, and again when they are powered down.

I used only one breadboard unit, as in Photo C. In my experience, you can run into a lot of trouble if you put any more than three or four chips on a breadboard at a time. The wiring gets messy and the connections become more unreliable as the amount of wiring increases. I generally use the breadboard to test out a small circuit design so that any problems I am chasing are associated with design rather than test equipment.

Using It

Plug it in and check the output posts for the correct voltage. You should have a +5-volt supply, a +12-volt supply, and a -12-volt supply. Decide what chip you want to test and place it in the breadboard. Run the appropriate voltages from the power supply posts to the breadboard, and hook the chip up according to the data sheet. Now you are ready to change the input to the chip and measure what happens to the output. Good luck on your designs! RF

Longer Range Reception with the Medium Wave Portable Radio

by Richard Q. Marris G2BZQ

Medium wave transistor portables receive signals via a horizontally mounted, small inbuilt ferrite loop antenna. Depending on the RF circuitry and design of the ferrite loop, it should be possible to receive AM broadcast stations, during the hours of darkness, from 500–1,500 miles away. Reception, of course, depends on receiver efficiency and location, QRM/QRN, and the power and location of the transmitting station.

Many countries, worldwide, have medium wave AM broadcast stations, and many enthusiasts with a really good receiver and a good antenna (such as a frame loop) quite regularly receive trans-Atlantic stations in the depth of the night, especially in the winter.

It is possible inductively to couple a portable transistor radio, with a built-in ferrite loop antenna, to a much larger box frame loop, and thus substantially increase weak signals and also receive signals from much longer distances.

The polar diagram of a box frame loop is shown in Figure 1A. The maximum signal is received on the ends, with a null at 90°. The ferrite loop, mounted horizontally in the receiver, has a polar diagram as in Figure 1B, in which the maximum signal is received on the long side, and the null at 90° at the rod ends.

In an inductively coupled arrangement, it is necessary to couple the two loop polar diagrams (Figures 1A and 1B) to achieve a polar diagram, as in Figure 1C. Figure 2, in which the portable receiver is mounted inside the larger frame loop, illustrates how this can be achieved

The author's medium wave assembly is intended for use with a Grundig receiver, and also with a Matsui MR-4099 all-band radio having continuous coverage from 150 kHz to 30 MHz. The Matsui also has a BFO, effective RF-gain control, and optional manual or digital tuning for accurate frequency measurement. It also has a useful LED S1-5 signal strength indicator.

The target frequency range for the inductively coupled loop assembly was 1600 kHz to 500 kHz. (500 kHz can be received on the Matsui but not on the Grundig.) The resulting range, on the prototype, gives an actual range of 1620 kHz to 470 kHz.

Photo A. The portable radio sitting within the box frame loop antenna.

The Circuit

The circuit of the loop consists of nine wire turns wound around a 24" wide by 30" high timber frame, resonated by C1, which is a two-gang 365 pF and 365 pF variable capacitor such as a Jackson type O or similar item. The two 365 pF sections are wired in parallel, with a 330 pF silver mica capacitor C2 in series with one section (see Figure 3). The medium wave receiver is enclosed by this nine-turn frame loop as shown in Figure 2.

Construction

Construction is low cost and very simple. See Figures 2 and 4.

A frame 24" wide by 30" high is constructed as shown. The sides and top use 1-1/4" wide by 3/8" thick seasoned timber, and the bottom is made from 1-1/4" wide by 7/8" thick timber. The extra thickness increases the bottom weight. The corners are adhered with wood glue, with two panel pins tapped in just inside the edges, to hold in position until the glue has hardened, at which point the pins are removed.

The portable radio "shelf" is cut 12" long by 3-3/4" wide and 3/8" thick. Its end supports are 1-7/8" high by 3-3/4" wide by 7/8" thick. The height can be increased, if necessary, to give clearance, depending on the actual type of two-gang variable capacitor used. The "shelf" is pinned and glued as in Figure 4. The whole timber assembly was finished in teakwood stain. The two-gang vari-

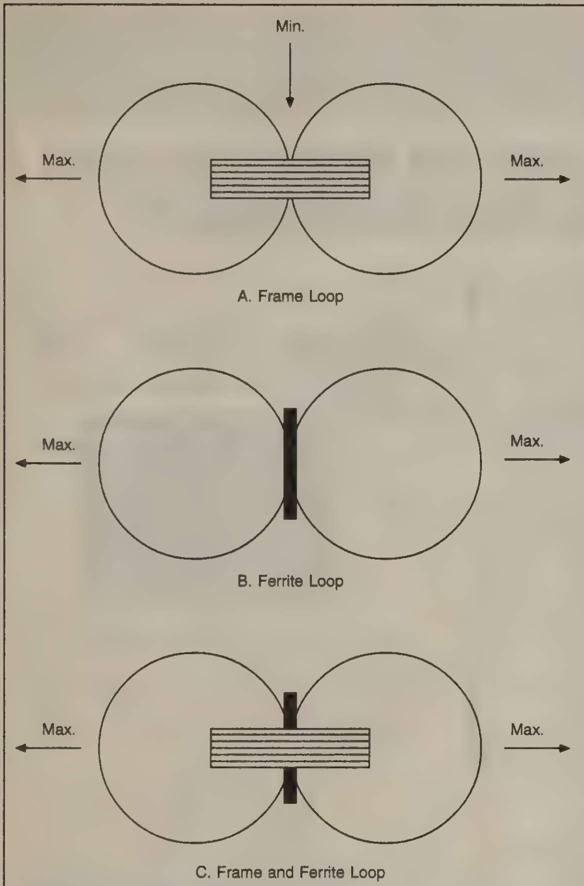

Figure 1. Loop polar diagrams

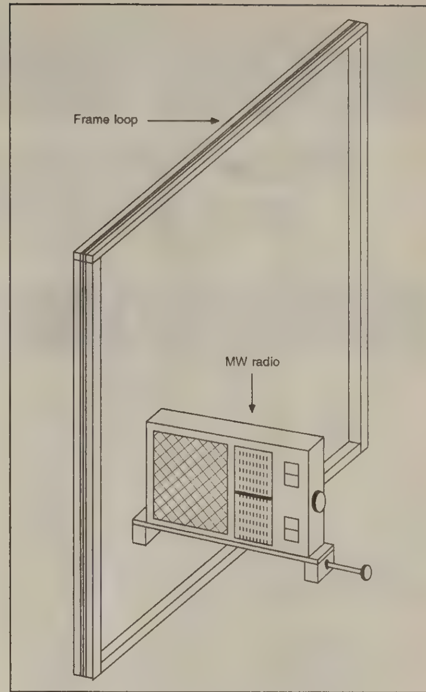

Figure 2. Unit profile.

able C1 is mounted under the shelf, near the loop wire ends, and fitted with an insulated shaft coupler going through a hole in the front support to the control knob.

The loop winding is nine closewound complete turns of PVC-covered 10/0.1 mm connection wire (o/d = 0.9 mm) closewound around the outer frame, as in Figure 4, and connected to C1 and C3, as in Figure 3.

Testing and Operation

To test the inductively coupled loop, tune the radio to a weak signal around the middle of the MEDIUM WAVE band. Put the radio on the frame loop "shelf," as shown in Figure 2, and rotate C1 to resonance, at which point there will be a quite appreciable increase in signal strength. Rotate the whole loop assembly for maximum signal (see Figure 1C). A simple nonmetal turntable will greatly assist. The loop should also be placed on a nonmetallic surface such as a wood table. Next, check the assembly at both ends of the medium wave band, and at 500 kHz, if the radio covers this. Around 500 kHz there is still CW activity to be heard.

In operation the portable radio should be used in the usual way, out of the loop, on which C1 should be left at maximum capacity. If a weak signal needs boosting, then place the radio on the "shelf," and bring C1 to resonance, which should quite dramatically increase the signal. Rotate the whole assembly as required, as the loop is directional. The loop will not work on very strong local signals, as this produces a form of overcoupling, with a dip in signal strength.

Alternatively, if a search is to be made for a distant station on a known frequency, then the radio should be pretuned to that frequency, placed on the frame loop "shelf," and brought to resonance with C1. If conditions are suitable, you live in a suitable location, and the right time of night is selected, then it should be possible, with care, to receive long-range stations, such as between Europe and North America. In all cases it is assumed that a high-quality radio is being used. RF

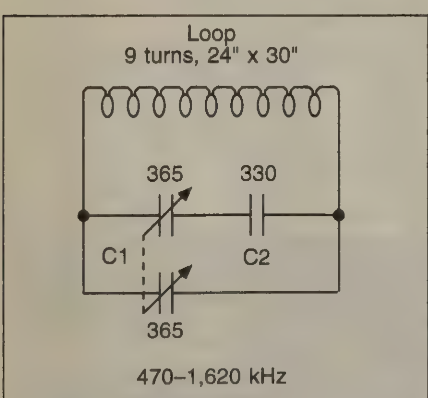

Figure 3. Frame loop circuit.

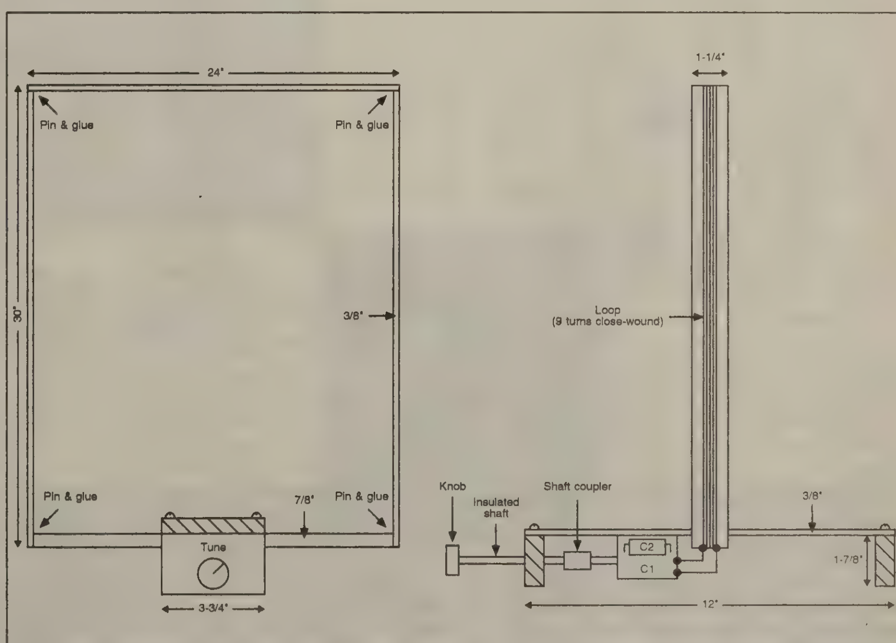

Figure 4. Frame loop.

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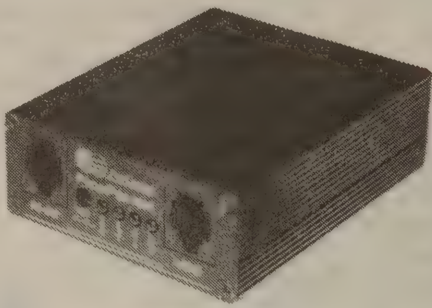

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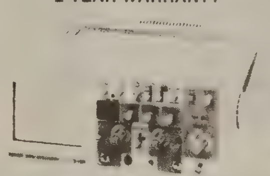

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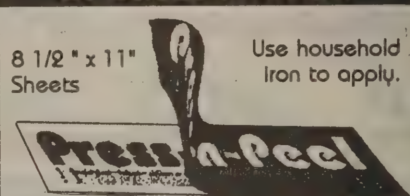

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CODEMASTER V Morse Code

Every ham brushes up against the code at some point in his or her career, with varying results. Some take to it with no problem, and have a great time work ing high-speed CW contests. Some are less successful, and maybe even forego the chance to upgrade because of it. There are various methods available to those who want to improve their Morse skills—copying off the air, making QSOs, using cassette tapes, studying with a friend—but perhaps the best tool available for the would-be CW wiz is the personal computer. Personal computers have many characteristics that make them ideal tutors. The computer has a flawless fist, has infinite patience, and can even remember your "difficult" characters! Time spent in front of the computer may be the most effective way to increase your code speed in a hurry.

A recent addition to the list of available programs is the CODEMASTER V program from Milestone Technologies. CODEMASTER has features that make it useful for everyone, from expert right down to someone who doesn't know a single Morse character. Whether you're a beginner just starting out, or an old timer who simply wants to sharpen up your skills, CODEMASTER has a feature that will be make it easy to improve your Morse code ability.

Features and Performance

If you've never studied the code before, a good place to start would be the **Basic Morse Training** option. This opens up a screen with two main screens: **Learn Morse Code** and the **MorseMonster Game**. The **Learn Morse Code** option gives you a choice of eight separate groups of characters to learn at a time—for instance, AXCWT or HBDIJ. These groups are tackled one at a time, and as each group is learned it can be added in to the next group to allow the student to build on his existing knowledge. Note that some of the "harder" characters are included right off the bat. Rather than employing the old easy-to-hard method (T- M-- O---, etc.), in which all the nasty stuff is saved for last, this character grouping sprinkles in the more difficult letters right up front. In the **Learn Group** mode, the characters are sent in the same order as they are listed in the group, three at a time. After a 1-second delay the character is displayed on the screen, giving you time to think before the answer is displayed. The **Practice Group** mode works in a manner similar to the learn mode, except that the characters are sent in a random manner, allowing them to be written down and checked for accuracy (no peeking!). Finally, the **Practice Groups 1-n** mode allows any combination of the first *n* groups to be randomly sent. By the time the eighth group is finished, all eight groups will have been randomly sent—all the letters, numbers, and punctuation. At this point you can start working on increasing your speed, and you'll also have the confidence to get on the air!

If all this learning and practicing seems too much like school, the **MorseMonster Game** should supply some relief. While not exactly a high-resolution 3-D super-VGA video game, MorseMonster is a lot of fun. Similar to the "letter drop" functions of some typing programs, this game drops "bombs" from an overhead monster. Oddly enough, the bombs seem to whistle as they fall and, if you listen closely enough, you'll find that the whistling is actually a CW letter being repeated over and over. Typing that letter on the keyboard causes the bomb to explode harmlessly in the air, not unlike the Patriot Missile scenario. As the bombs get closer to earth, the speed of the CW decreases, making it easier to save the earth. In addition to being a good time, MorseMonster is actually quite humbling, especially on the expert level. When those bombs come down at 40 wpm, it's pretty clear that you don't have a clue; however, they repeat over and over until they're slow enough for even the slowest op to copy. MorseMonster gives an overall speed rating based on how well you did for a series of bombs, but it should be noted that this is a relative rating. Not only do you have to recognize the letter before it hits the earth, you must locate and hit the right letter on the keyboard. Not a big deal if you're a touch typist or you want to practice using the "mill," but for the casual operator it can be a little tricky. In addition, the letters repeat as soon as the current letter is finished, meaning the Es come a whole heck of a lot faster than the 0s. In any event, MorseMonster is great fun, and only slightly addictive.

Once you have learned the code, there are several ways to improve or keep up your speed. CODEMASTER will send random **Character Groups**, not unlike the commercial tests and military practices of the old days. Although somewhat brutal, random letter groups quickly separate the men from the boys as far as code proficiency is concerned. If you can copy 20 wpm code groups, you can copy 20 wpm anything. As with most features of the CODEMASTER V program, random groups can be customized. If you want your groups to be 8 characters long, containing just prosigns, numbers, and punctuation (or something equally abusive), it's no problem.

As code proficiency increases, you begin to copy complete words rather than individual letters. In order to practice this skill, the program allows a file of **Random Words** to be sent. In addition, a file of various **Callsigns** is included to sharpen your ear for letter combinations likely to be heard in a callsign. A **Tests** option sends three different tests for each of the three US Morse qualification speeds. Tests contain all of the alphabet, the numbers, the prosigns, and punctuation. The test is transmitted following a short countdown, and the screen remains blank during the test. After the test is finished, the text is displayed on the screen, allowing you to check the test for accuracy. Moreover, you can modify any of these files as desired, or create and load different files into the program. CODEMAS-

TER V will also send plain text files—any file in ASCII format. This would be useful for sending code for test purposes to a group, transmitting local bulletins to the club (as long as you weren't broadcasting), or simply letting the user copy fresh material. Complete instructions for file creation and manipulation are included in the accompanying manual.

Two other functions round out the features of CODEMASTER. The **Keyboard Echo** function simply sounds each character that is typed on the keyboard. This is useful for those having just begun to learn the code, or for practicing with a friend who may not know Morse Code at all; if the friend can type, he or she can send Morse! Because this function makes use of a buffer, the user can "type ahead" of the sound and, as long as the proper spaces, and so forth, are typed in, the code will come out perfectly. As a matter of fact, if you are typing a word or two ahead of the code being sent, you can make a mistake, backspace to correct it, and still have it come out all right. The other function, also useful when practicing with a friend, makes the computer into a simple code oscillator (okay, a $1900 code oscillator . . .). The **Ctrl** and **Alt** keys become hand keys; as long as you hold it down, the tone sounds. Whereas banging on the **Alt** key with your index finger is not conducive to machine-like sending, especially beyond about 10 wpm, this feature makes it fun and easy to practice quickly your sending skills, either with yourself or for a buddy to copy.

A great deal of flexibility is provided via the Program Configuration screen. Character speed, overall speed, pitch, random group characteristics, "hard" characters (your own personal favorites)—you can adjust all to fit your preferences. This configuration allows you to take advantage of the method whereby the individual character speed is quite high, and the overall word per minute speed is much lower. This forces the trainee to learn the sound of the characters at high speed, so when the actual speed increases to this point the characters don't sound any faster. In turn, this process eliminates the "plateau effect" commonly found when letters are initially sent at four to five words per minute, and gradually increased. This system, called the Farnsworth method, is extremely effective for rapid progress in CW education. Of course, CODEMASTER allows you to set the speed for standard spacing, if desired.

Conclusion

CODEMASTER works on virtually any PC, even that old 512K single-floppy drive beast you have in the ham shack. Installation is a breeze with the built-in install program, and the program takes up a measly 358K on the hard drive. Priced at only $24.95, CODEMASTER V could be the best investment you make toward your next ham ticket. RF

What you missed in *73 Amateur Radio Today*

If you don't read the September issue of *73 Amateur Radio Today*, here is some of what you're missing:

• Since we have those signals anyway, why don't we make "Boring Beacons" kill two birds with one stone? D. R. "Kuby" Kubichek N6JSX tells how he makes his beacon carry "seismic waves!"

• Phil Salas AD5X might have been tuning on a beacon to work up his "QRP Delight." He shares his results: a full-featured antenna tuner with built-in SWR meter.

• But if you want your QRP unit to bulge some muscle, give a read to Steven Weber KD1JV as he tells you all about his "DDS Dream VFO."

• The sun is free for the using, right? There's plenty of power to run a QRP rig if you have something like Everett James K4SYU's "Portable Solar Electric Power Generator."

• There's something to be said for classic designs, and David Cripe KC3ZQ says it! He tells you all about building a high-performance, regenerative short-wave receiver in "Armstrong Updated."

• You'd want to do more than receive, but why settle for operation on just two bands? Klaus Spies WB9YBM lays out a pretty simple interface for you to "Link it All!"

• A lifetime of ham experience should count! That's what Hal (Doc) Goodman WN3UWH thinks, when he suggests a special "Senior Citizens Upgrade."

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• Everybody's making 20 meter QRP rigs these days, but Peter H. Putman KT2B thinks the "Ramsey Electronics SX-20 QRP SSB/CW 20m Transceiver" is something special in a kit. With DDS, dual VFOs, RIT, and more for around $350, he's probably right.

• And Peter J. Bertini K1ZJH celebrates Maggiore's 25th anniversary in the ham trade with a great review of their 2 meter VHF unit, "The Maggiore Hi Pro R1 Repeater."

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Antennas, etc.

by Joseph J. Carr K4IPV

Build a Curtain Array

Who says you can't get gain out of a wire antenna? I overheard a conversation at the Gaithersburg (Maryland) hamfest between two chaps who held very strong opinions on antennas. One of the fellows maintained (wrongly!) that gain could only be obtained in antennas such as yagi beams, and that simple wire antennas nearly always performed similarly to dipoles. I asked him if he'd ever heard of the longwire, the vee-beam, the collinear array, the bobtail curtain, the cubical quad, all of which are wire antennas that produce gain. Since my question was lost on the lad, I pressed on, looking for more antique radios (I wanted a Hallicrafters SX-28A in good condition, but still haven't found one).

Two Important Considerations

Before tackling an antenna project, let's look at the matter of "gain" and "directivity." Actually, while these qualities are not the same, they are basically different ways of looking at the same concept. When one talks about gain, the question is always "compared to what?" Two different reference standards are used in amateur radio antenna literature: the half wavelength, center-fed dipole, and the isotropic source.

Gain is usually measured as either a power ratio or as a number of decibels (dB). For example, suppose we say an antenna has a gain of 3 dBd ("decibels gain over a dipole"). A 3 dB change is a 2:1 power ratio, so it's like saying that it would take 200 watts into a dipole to produce the same strength signal "downrange" as 100 watts into a dipole (assuming both antennas are fired in the same direction).

Professional antenna engineers don't use the dipole as the reference antenna, but rather they use the isotropic source. This is a theoretical device (no one actually builds isotropic antennas) that radiates power equally well in all directions. And since antenna patterns are three dimensional, it means that it has a spherical radiation pattern, with the isotropic source at the center. If you look on the surface of the sphere, any given power level applied to the isotropic radiator will result in a certain power density of so many watts per square meter (W/M^2).

When we look at a real antenna, like a dipole or a beam, we note that it has directivity. The dipole pattern looks like a doughnut in three dimensions, but from above it's the classic "figure 8" that you see in textbooks. In both elevation and azimuthal aspects, the directional antenna projects a solid section of power that subtends Az and El angles on the surface of the isotropic sphere. A magic observer in space above the sphere, looking straight into the oncoming signal, would see that patch of energy and could measure its area. If you divide the surface area of the entire sphere by the area of the path produced by the antenna being measured, then you have the power gain ratio (approximately 52,500/A according to W6SAI's *Radio Handbook*). The comparison of the area of the radiated antenna signal with the entire surface area produces the gain (G) of the antenna, and to find the decibel expression calculate dBi (decibels over isotropic) 10 log (G).

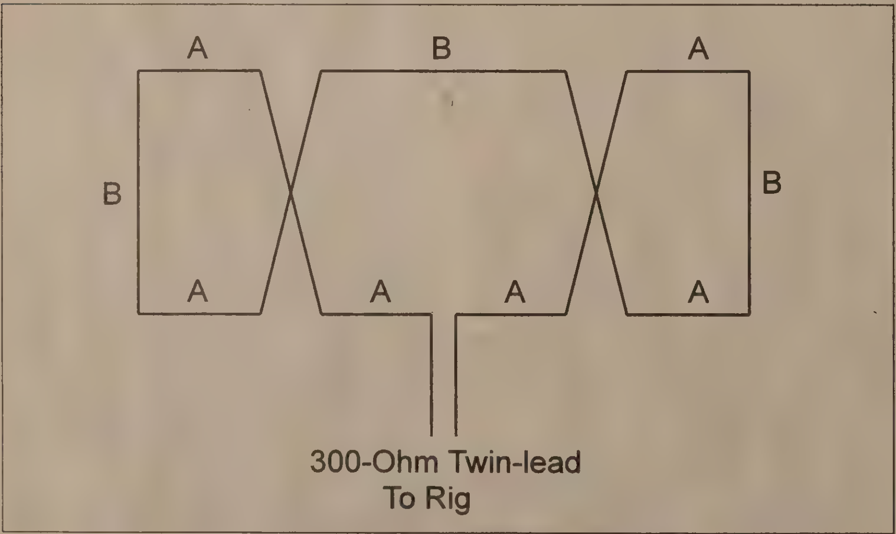


Figure 1. Basic center-fed Sterba curtain array.

A Wire Array Antenna

There are a number of ways that we can make gain antennas with bits of wire and insulators. In this month's column, we are looking at two array antennas . . . . well, actually the same antenna fed in two different ways. Figures 1 and 2 show the basic Sterba (named after the inventor) curtain array antenna. The Sterba is a broadside area, and the bidirectional signal is perpendicular to the array. It consists of both collinear and parallel array elements. This antenna has a gain of about 6 dBi, yet can easily be constructed from wire and insulators, and supported with rope.

The sections marked "A" are quarter wavelength, while those marked "B" are half wavelength. The dimensions are:

$$A = 246/F_{MHz} \quad (1)$$
and
$$B = 492/F_{MHz} \quad (2)$$

As you can see, these antennas can get a bit large, especially at lower frequencies. For example, at 7.2 MHz in the 40 meter band, the "A" sections are 34' 2" long and the "B" sections are 64' 4" long. Thus, the antenna would be on the order of 128 feet long (which is about the length of a 75 meter half wavelength dipole or an "all-band" trap dipole). While this size isn't a huge problem for many readers, it is prohibitive for many others. At 10-meters, the situation is greatly improved because the antenna sections are (for 29 MHz) A = 8' 6" and B = 17'; therefore, the overall antenna is only 34 feet long—way easier to fit onto a lot. Heck, I even met one guy who claimed to have a 10 meter Sterba array in the attic of a townhouse. I don't know whether or not to believe him, but he makes the claim.

The difference between Figures 1 and 2 is the point of feed. Both are fed with 300-ohm twin-lead (for low power), or the equivalent parallel line if high power is intended. You should route the twin-lead to an antenna tuning unit with a balanced output, or, alternatively, some people use a 1:1 BALUN transformer at the feedpoint, and then run 75-ohm coaxial cable to a coaxial-type antenna tuning unit.

One final version of this antenna is the multisection version shown in Figure 3. This antenna is basically an extension of Figure 1, and has a gain of about 8 dBi. The dimensions are calculated as above, so the antenna gets quite large on lower frequency bands. Some international shortwave broadcasters used Sterba curtain arrays with many more sections, and thus higher gains. One broadcaster QSL card, the kind sent to shortwave listeners, shows a Sterba curtain that's about a city block long and as high as a four-story building. Wow! Wouldn't you like to DX with that antenna?

One place where the Sterba curtain array is quite practical is in the VHF bands. Over the years, I've talked with people who have used the Sterba on the 2 meter ham band (144 to 148 MHz), on the VHF television bands, and on the FM broadcast band. One chap to whom I talked (on the air) a number of years ago (too many!) was a long distance from the nearest television station (operating on Channel 7), and he couldn't afford a high-gain, multi-element Yagi. In those days, there were no satellites sending TV signals down; thus, no home satellite dishes existed. He claimed to have build a Sterba curtain that was more than 150 feet long! I don't know how many elements it had, although a few calculations would produce a reasonable guesstimate. He claimed that the TV signal was strong enough to make a reasonably noise-free picture, yet the antenna was built from a couple of spools of #14 stranded copper wire and a box of hamfest-special ceramic or glass insulators. Poverty makes us all inventor-geniuses!

You can contact me at P.O. Box 1099, Falls Church, VA 22041, and I welcome comments, questions and criticism.

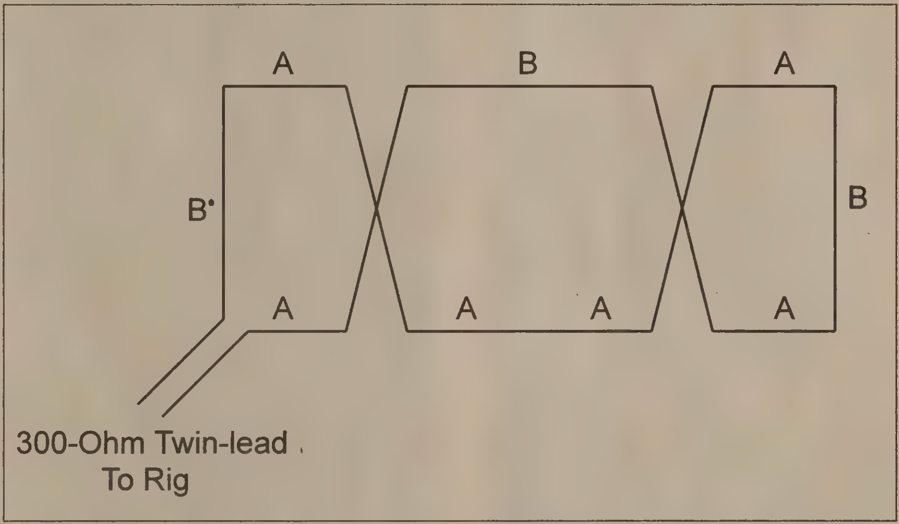


Figure 2. Corner-fed array.

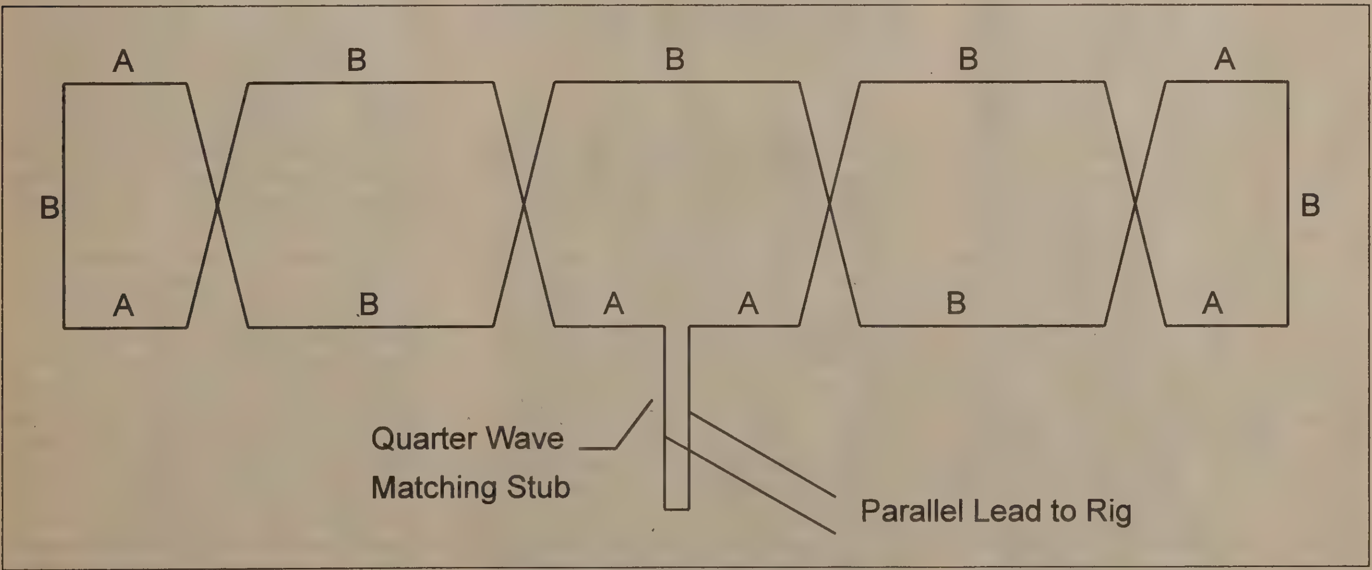
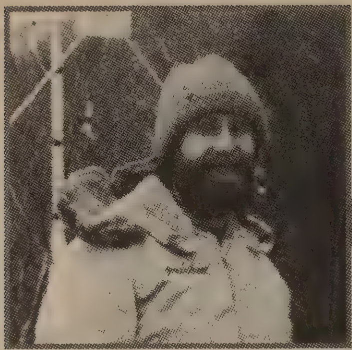


Figure 3. Longer Sterba array.



The Tech Side

by Michael Jay Geier KB1UM

Be Quiet!

Last time, we explored the transmitting of sound, which, as hams, is probably our most frequent activity! This time, let's look at the opposite: silence. I'm talking about squelch circuits: how they work, why we use them, and how the different kinds affect our radio operations.

Shhhh!

For the most part, we use squelch circuits to avoid having our radios drive us crazy! Why do we need this, when our broadcast radios don't seem to require it? Well, with a broadcast signal, it's assumed you're listening to something that's on all the time. With two-way radio, though, signals come and go incessantly, leading to our having to listen to lots of background noise between transmissions. The effect of that can range from innocuous to extremely annoying, depending on what signal mode you're receiving. First, let's look at the three common modes and the squelch needs of each.

AM

On AM, background noise such as natural static (QRN) and manmade interference (QRM) can be somewhat irritating, but isn't generally a big deal unless there's significant electrical activity in the atmosphere (in which case you may want to turn the radio off and disconnect the antenna anyway!), the band is very crowded, or you're near some local source of noise, such as a bad insulator on a nearby power line. We hams don't use AM much anymore, though, so it rarely concerns us. Those who do like to run AM on 75 meters usually find squelch to be pretty useless, because the kind of noise you get down on that band tends to be from distant thunderstorms, which produce random, sharp noise spikes that open squelch circuits anyway.

SSB

Many newer multimode HF (high frequency) radios include squelch circuits that work in the SSB (single sideband) mode. I'm also including SSTV (slow-scan television), RTTY (radioteletype), and HF packet (another digital mode) in this category, because most of them are done using SSB. While SSB is a form of AM, it has some different characteristics. In general, it's less susceptible to static-type noise. Still, squelch can be sort of useful on SSB, but rapidly changing signal levels make it hard to find a squelch setting that lets you hear the other station while still quieting the radio between transmissions. In fact, with SSB, the squelch often opens and closes between syllables because, unlike AM, SSB has no carrier when there's no sound. The result is that it looks, to a squelch circuit, like the other station's transmitter is turning on and off. That characteristic makes it pretty frustrating. I'd venture that many hams who use the squelch on their HF rigs do so only when waiting for a friend to call, and turn it off once the contact begins. That's the only way I've ever gotten much use out of my squelch control.

CW

Although Morse code is a carrier-based mode like AM, with code the carrier really does turn on and off, making its squelch characteristics something between AM and SSB. The carrier makes squelch pretty useful, because it's easy for the radio to tell the difference between signal and noise. Still, the same signal-strength fluctuations that plague any HF mode apply to code, making it hard to find a useful control setting, just like on SSB. I doubt many CW operators use squelch. In fact, lots of them prefer QSK, which means the receiver becomes active between dots and dashes, making for an almost simultaneous transmit/receive system. They like it because it lets other operators interrupt their sending, which is handy with CW since it takes so long to get information across, even at high code speeds, that it's easy to fall into a monologue and keep sending, even when someone else has something to say, such as "you're fading out and I can't hear you anymore!" Remember, even at the Extra-class rating of 20 words per minute, you're only communicating at about one tenth the speed of the average voice contact.

FM

Here's where squelch really shines. Whereas you've probably seen lots of SSB radios lacking squelch controls, I'll bet you've never seen a two-way FM radio without one! (Cellular phones don't count here, because they're similar to broadcast radios: You're assumed to be always listening to a signal whenever the unit is turned on.) In fact, we really couldn't use FM on our ham rigs if it weren't for the squelch circuit!

The reason has to do with the basic structure of an FM receiver. In order to gain the primary benefit of FM, which is its immunity to noise, the receiver has to remove the noise pulses before the signal gets to the detector. Since, unlike an AM signal, an FM signal's amplitude carries no information, the receiver doesn't need to preserve the "envelope," or wavers, in the incoming signal's strength. So, it removes the noise spikes by amplifying the signal past the receiver's own limits, causing the tops and bottoms of the waveform to be clipped off. It's exactly the same "clipping" effect you get when you turn your stereo up too loud and it starts to distort. This time, though, it's a desirable thing, because it clips off the noise, too! What's left is a fairly noise-free signal with flat tops and bottoms, ready to go to the detector. Since only the frequency wobbles of the

signal carry any information, that's just dandy.

I mention all this because it leads to an effect peculiar to FM radios: When there's no signal, the extreme amplification used in clipping revs up the radio's own internal noise, along with any noise coming in via the antenna, turning it into what the detector thinks is random modulation—and quite a bit of it. That results in the loud "whooshing" sound you get when an unsquelched FM radio is tuned where there's no signal. It's enough to make you want to throw the thing out the window, because nobody could stand to be in the same room with an unsquelched FM rig for very long. So, squelch is more than desirable on FM; it's essential.

Other Uses

Not all radios are listened to by human ears! More and more these days, the output of a ham radio may lead to some sort of decoder box or computer. Often, it's some kind of digital decoder for RTTY, one of its variations like AMTOR, or packet, but it also may be an SSTV system. You may wonder why anything without a nervous system would need squelch. Actually, many decoders depend on it to tell the difference between a signal they should be trying to decode and noise. While some packet radio decoders are made to be run with the squelch open, many are not and will get hopelessly bogged down trying to make sense of random noise if you try to run them unsquelched. SSTV systems, too, may fill the screen with garbage, for the same reason. Yup, machines like quiet, too!

How It Works

Now that we've looked at why squelch is important, let's look at how it is accomplished. It might seem obvious that the circuit just looks for signal strength, but that isn't always the case. In fact, there are many kinds of squelch systems. Here are a few of the more important ones:

Carrier

This does, indeed, use signal strength to open and close. It's used on AM, SSB, and CW. Although some early circuits actually measured the signal level in the IF (intermediate frequency—that is, before the detector) stages, and others measured the audio level after detection, it generally isn't done in either of those ways anymore, except perhaps in some simplified QRP (low-power) rigs. Nowadays, carrier-level squelch is sensed by measuring the AGC (automatic gain control) voltage the receiver uses to try to keep the incoming signals constant. The stronger the received signal, the bigger that voltage gets as it clamps the receiver gain down. By the way, that same voltage is used to drive your S-meter, so it's easy to see how it can be used to set a threshold for opening and closing a squelch gate.

Noise

On FM, carrier-operated squelch just won't work, because, in the absence of a signal, the clipping effect of the over-amplified IF stages produces lots of random "signal" anyway! So, the squelch circuit would have no way to know when it was seeing noise and when it was seeing the real thing. Another method has to be used.

Although strength readings won't reveal whether there's a real signal on FM, that noise-generating characteristic of the receiver can be turned to advantage. Noise has one property that a real signal lacks: excessive high-frequency components. In other words, there are high-pitched, hissy sounds in noise that aren't present in transmitted signals, thanks to transmitters' deliberately limited audio bandwidth of only about 3 kHz. How do you detect those high-pitched noises? It turns out to be easy. All it takes is a resistor and a capacitor to form a simple high-pass filter that will remove all but that high-frequency hiss. Then, you just measure how much hiss there is, and open the squelch when it disappears! It sounds odd, but that's how FM squelch circuits actually work.

By the way, if you've ever had your 2 meter rig's audio cut in and out while listening to a highly modulated signal you knew was too strong to fall below the normal squelch threshold, it may be because the overmodulated signal contained enough high-frequency sounds, like "s" and "t," to fool the noise circuit in your rig into thinking the signal had momentarily disappeared. I've seen handhelds, mobiles, and even repeaters do that when somebody had his transmitter's "deviation," or modulation, turned up too high.

Other Methods

There are other ways to decide when a receiver's audio turns on and off. Some of them operate by themselves, while others can be used in conjunction with a regular signal- or noise-operated squelch.

Some radios use what's called digital squelch. This opens up the sound only when a specific digital code has been received. A lot of new walkies offer that approach as an option. It's usually used in conjunction with regular squelch, in order to avoid having the digital decoder go nuts trying to decode noise.

There's also tone-operated squelch. Into that category fall such systems as DTMF (dual-tone, multi-frequency, or telephone keypad tones) and CTCSS (continuous-tone-coded squelch system). DTMF usually requires regular squelch as well, but you can use CTCSS with the receiver wide open, because it won't lock onto noise. That makes for faster lockup time in some cases.

Some packet radio controllers are made for use with unsquelched receivers, because, on packet, the time it takes for the squelch to open up can significantly slow things down. These controllers have special circuits that are immune to noise, yet can identify a valid digital code instantly.

Finally, there's voice-operated squelch. Uncommon in ham radio, but heavily used by the military, where cost is no object, this sophisticated circuitry can tell the difference between noise and human vocal sounds. It's far and away the best system for HF SSB, but I think it'll be awhile before it starts showing up with any regularity in ham radio gear.

Well, I hope you've enjoyed this look at the world of quiet. Until next time, 73 from KB1UM. RF

What's Next?

by Carole Perry WB2MGP

Mayday Mission

As any successful teacher or instructor can tell you, the key to getting someone's attention so that their learning can be maximized is to have a great motivational technique. With the start of the new fall term, I hunted around looking for a highly motivating lesson with which to kick off the unit on Space Travel and Communication. There are so many terrific activities to use with both children and adults in this area. I've developed a sizable repertoire of lessons and activities that I'll be happy to share with my readers. The following "Mayday Mission" was published in the September edition of *Learning '94* magazine. It's a great icebreaker for any age group you may be teaching. It also leads to terrific discussions and thought-provoking disagreements. I strongly recommend that you give this one a try.

Tell the group to pretend they have been stranded on the moon with 15 items. Ask them to rank the importance of each item. You can divide the class into teams and let them each come up with their own lists. Give the groups time to discuss and debate. They must be prepared to justify their ranking order. Later you will read them NASA's ranking so that everyone can see how he or she did. This could be a fun team activity or just an individual challenge.

Here are the 15 items: box of matches, food concentrate, 50 feet of nylon rope, parachute silk, portable heating unit, two .45 caliber pistols, dehydrated milk, two tanks of oxygen, stellar map of the moon's surface, self-inflating life raft, magnetic compass, 5 gallons of water, signal flares, first-aid kit with injection needles, solar-powered FM receiver/transmitter.

After allowing plenty of time for everyone to voice his opinion, you can put NASA's ranking on the board starting with number 15 first. Or, you can have the list printed up to hand out to the children. Suggest that they bring the list home and try it on their parents to see how they do.

The answers, with NASA ranking and explanations, follow:

1. Two tanks of oxygen—Necessary for breathing
2. Five gallons of water—Necessary for survival
3. Stellar map of moon's surface—Means of finding directions
4. Food concentrate—Supplies necessary nutrition
5. Solar-powered FM receiver/transmitter—Could transmit a distress signal and help in communicating with the mother ship
6. Fifty feet of nylon rope—Useful in securing injured crew members and helpful in climbing
7. First-aid kit with injection needles—Helpful in treating injuries
8. Parachute silk—Provides shelter against the sun's rays
9. Self-inflating life raft—Carbon dioxide bottles useful for propulsion across chasms and so forth
10. Signal flares—Could be used for distress call when ship is in sight
11. Two .45 caliber pistols—Could use for self-propulsion
12. Dehydrated milk—Could provide necessary nutrition
13. Portable heating unit—Provides warmth on the moon's dark side
14. Magnetic compass—Useless because the moon probably has no magnetic poles
15. Box of matches—Little or no use on the moon

You will be amazed to see how involved in this project everybody becomes. Especially the kids! I have one of the students transcribe the final choices on separate paper and I save it until we get into the SAREX (Shuttle Amateur Radio Experiment) material. The more the students learn about space and the role of radio, the more fun you will all have as you look back on your earlier rankings. If you try this activity and have an especially successful response, please write and let me know so that we can share your experience with others. Have fun! RF

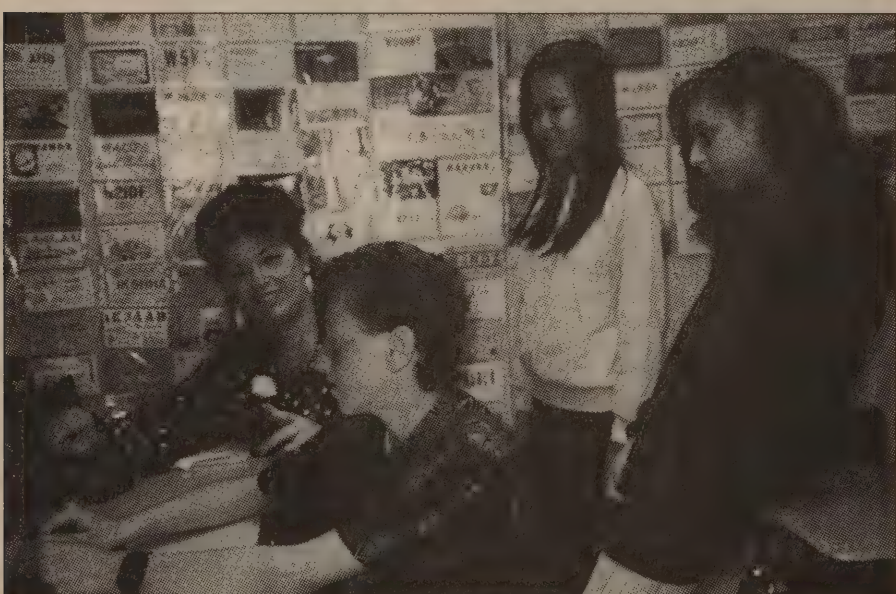


Photo A. Always remember: Having fun is the best motivational technique for learning.

Radio Magic

by Michael Bryce WB8VGE

Where'd All the Kits Go?

Having hands-on experience with electronics goes a long way toward your understanding of ham radio. One of the best ways to get hands-on experience is to build electronic kits.

In fact, in the early 60s there were more kits than commercial equipment on the air. And of course the leader in electronic kits was HeathKit, with Knight kit a very close second. Thanks to Heathkit, you heard, "The rig here is a hot water 101" all over the bands. Well, Heathkit is no longer making kits, and Knight kit shut down long ago.

There were many different reasons for the decline of large kit building. Some of the kits were as expensive as ready-built gear, while other kits did not perform as well as commercial units. And, people just did not have (or want to spend) the time to build a complex kit such as an SSB transceiver.

For awhile, you simply could not locate electronic kits for ham radio. But, that's all changed during the first few years of the 90s. Now, there's a wealth of kits out on the market. Some are rather complex while others are geared toward the newcomer. Let's look at how kit building can be both fun and rewarding.

A Place to Work.

No matter if the kit is as simple as a code practice oscillator or as complex as a PLL transceiver, you'll need a place to set up shop. Now, don't even think of using the kitchen table. Unless you're single, then it's all right. You need a place to work that you can allow to remain cluttered, if need be. Kit building should be fun and not rushed. But it's not enjoyable if you spend half of your time cleaning up your work area so the family can eat.

Many of the newer circuits contain some extremely small parts. Since you'll need a source of glare-free light, you can purchase a hand-held light at most office supply/art supply stores.

Also, a circuit board holder, which I've only recently started to use, is very handy to have. Panavise sells one, and it's the unit I own. After years of stuffing PC boards the hard way, employing a holder does require some adjustment. Still, I recommend using it, even if it is a homemade jobbie out of wood.

The Right Tools

Just as you don't use a sledge hammer to repair pocket watches, you should use the proper tools when assembling your kit. Radio Shack carries a fair amount of electronic hand tools. Look for their upper-end tools and don't be taken in by cheap prices. Cheap tools will only bite you in the butt down the road. Sears also offers a wide variety of small hand tools for electronic repair. Most of the larger electronic supply houses, such as Mouser and Digi-Key, also sell hand tools as well as soldering irons.

As a minimum, you should get the following:

- Set of slotted screw drivers.
- Set of crosspoint screw drivers.
- A complete set of TORX screw drivers (some newer radios use these crazy screws).
- Two needlenose pliers, one with an extra long nose for those hard-to-get-at places.
- A high-quality soldering iron with interchangeable tips. The iron's wattage should be between 18 and 35 watts. If possible, get a soldering iron that has a grounded tip. This will help you avoid damage to static-sensitive parts such as CMOS chips.
- A second soldering iron with a wattage of at least 45 watts, perhaps larger. You'll need one of these guys for soldering PL259 connectors and other large metal parts.
- Oh yes, don't forget the autorange digital VOM. Pick one up at Radio Shack, or do your thing via mail order. Radio Shack always seems to have one or two models on sale. If you have the money, pick up a second VOM, but this time make it an analog version. The analog meter is ideal for peaking up a tuned stage. It's easier for the brain to see the needle swing up instead of trying to count numbers.
- While you're at Radio Shack, pick up some desoldering braid. Grab two rolls of solder, one "light duty" and the other roll heavy duty. The thicker stuff works best for antennas and coax connectors. The thinner .062 gauge solder is ideal for PC boards. The thicker stuff makes it much more likely to generate solder bridges between pads.

Let's Begin

Now that you have a place to work and the proper tools, the very first thing you need to do is read the assembly instructions. Check for any updates the kit may contain. After you have read through the instructions, begin the assembly. Most kits start by stuffing the PC board and then moving on to the assembly of the board into its case. Some kits don't come with a case, as that is left up to the builder. Also, many kits don't come with the necessary wire for interconnections between the PC board and the real world. Unless directed otherwise, use 22- or 24-gauge stranded wire. Use various colors to avoid confusion.

Instructions

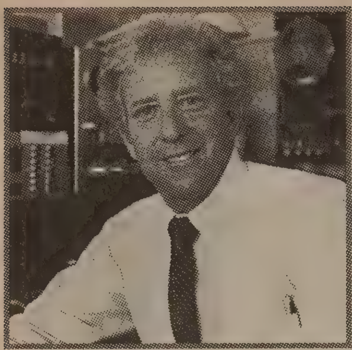
This is the one component that can make or break a kit. If the assembly instructions are unclear or have missing steps, the kit can be a disaster. No amount of troubleshooting can track down the faults if you assembled your kit by following screwed-up assembly steps.

The instructions should include a schematic, part overlay for the PC board, and tune up or calibration steps. The instructions may not include step-by-step guides for each and every part. Some of the smaller kits simply instruct you to "install all the resistors" and then "install all the capacitors," with nothing more said. Other times, you'll see very detailed assembly instructions with every step shown.

Building your own gear using kits is a lot of fun. It's even more enjoyable the first time you apply the juice and it works. But wait! What if you're not one of the lucky ones and your kit is dead on arrival? Well, next month we'll look at that problem, as well as others you may encounter.

Don't have a lot of money to try your hand at kit building? I have built up some more of the DYI keyer we did a year or so ago. The keyer is easy to build and lots of fun to operate. It makes only dots and dashes—nothing else. It's not an "iambic" keyer. The best part is the price, as it's still $15 for the complete kit. If you're interested, contact me at the following address:

2225 Mayflower NW
Massillon, OH 44646



Upgrade . . . Don't Stop Now

by Gordon West WB6NOA

Using dBs

The decibel is the most convenient term to use to indicate antenna gain and transmission line loss. A decibel, named after Alexander Graham Bell, is the smallest change in sound level that the human ear can perceive.

A decibel (dB) represents a power ratio or a voltage ratio. It is easy to use, since you *add* decibels instead of multiplying numbers. For example, 6 dB represents a power ratio of 4, or a voltage ratio of 2. If an antenna has 6 dB of gain, it will increase effective radiated power (ERP) 4 times. It will also increase the voltage level of the signal at a distant receiver 2 times (one S-unit).

You can save a lot of time and will know more about how to read technical specs if you use dB. Transmitter output can be expressed in dBm (0 dBm = 1 milliwatt) or dBW (0 dBW = 1 watt). Receiver input can be expressed in dBm or dBu (0 dBμV = 1 microvolt). Receiver audio output can be expressed in either dBm or dBW. Antenna gain can be stated in terms of dBi or dBd. Coaxial cable losses are always expressed in dB, as is space transmission loss. So is receiver selectivity. Also, so is harmonic attenuation.

To use decibels (see Table 1), you add or subtract them. You do not have to multiply or divide the decibels, as you do the ratios. To find out what is represented by a large dB figure such as 62.5 dB, add 60 dB and 2 dB and 0.5 dB. The answer will be 1000 (60 dB) times 1.259 (2 dB) times 1.059 (0.5 dB), which is equal to a voltage gain of 1333. If you are referring to power, multiply 1,000,000 times 1.585 times 1.122, which equals a power gain of 1,778,370 times. If the loss is 62.5 dB, divide the input voltage by 1333 or the input power by 1,778,370.

You don't have to use so many decimal points! The power left after a 1-dB loss can be written 0.8 (84 percent) instead of 0.7834. The attenuation in 5 feet of RG-58 coax is only 0.1 dB. The power left is 0.9772 of the transmitter output. You can't note the difference between 1 dB and 0.1 dB in the real world. But it's a lot easier to talk in dB language than in power and voltage ratios.

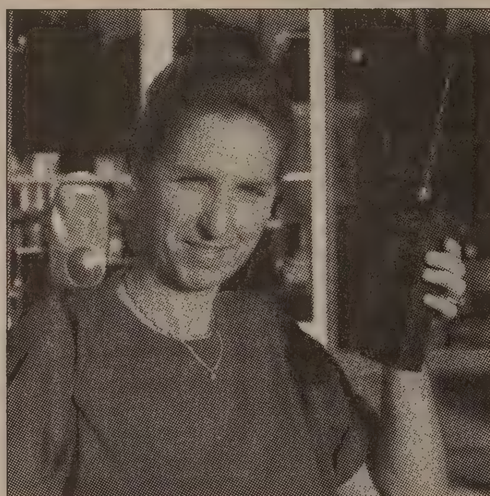


Photo A. Using dBs to calculate 2 meter hand-held range is easy, if you go by the numbers!

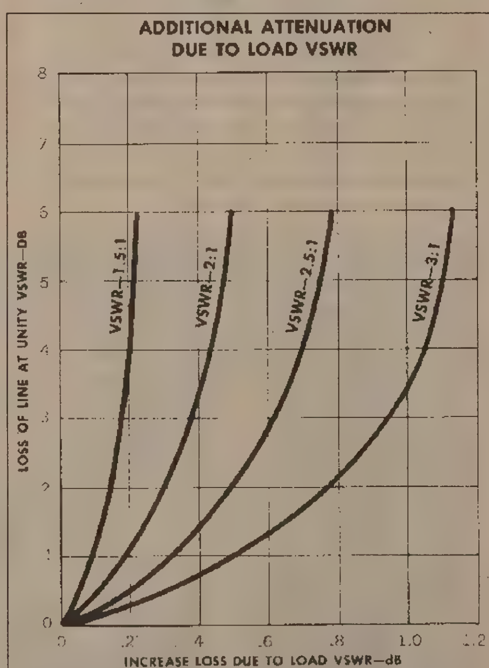


Figure 1. Additional attenuation due to antenna SWR. (Courtesy of Phelps Dodge).

Coax Losses

The attenuation of coaxial cable is expressed in dB. The loss in RG-58 cable at 27 MHz is approximately 2 dB per 100 feet. The loss in a 25-foot length is around 0.5 dB, which represents a power loss of about 10 percent. The additional loss due to SWR is shown in Figure 1. If SWR causes an added loss of 0.1 dB, power reaching the antenna will be reduced only by an additional 2 percent, which is negligible.

To find out how much your ERP is, measure the transmitter output power with an RF wattmeter. If it is 4 watts, the power level will be 36 dBm, as you can note from Table 2. If the coax loss is 0.5 dB, deduct 0.5 dB from 36 dBm and you will have 35.5 dBm. Then, if antenna gain is 3 dB, add 3 dB to 35.5 dBm and you will arrive at 38.5 dBm, which is equal to 7.12 watts.

Receiver Sensitivity

While receiver sensitivity is usually stated in microvolts, it can also be expressed in dBm (see Table 3). If sensitivity is 0.5 microvolts, it is -113 dBm. The S-meter indications for various input signal levels are also listed.

Receiver selectivity is usually expressed in dB. If adjacent channel rejection is 60 dB, it will require an adjacent channel signal 1 million times more powerful than an on-channel signal to produce the same receiver output level. The voltage level of the signal is 1000 times greater. For example, if a 1-microvolt on-channel signal yields a 100-milliwatt signal at the receiver output, it would require a 1000-microvolt adjacent channel signal to have the same effect.

Decibels vs Voltage and Power Ratios		
dB	Voltage Ratio	Power Ratio
0.0	1.000	1.000
0.1	1.012	1.023
0.2	1.023	1.047
0.3	1.035	1.072
0.4	1.047	1.096
0.5	1.059	1.122
0.6	1.072	1.148
0.7	1.084	1.175
0.8	1.096	1.202
0.9	1.109	1.230
1.0	1.122	1.259
2.0	1.259	1.585
3.0	1.413	1.995
4.0	1.585	2.512
5.0	1.778	3.162
6.0	1.995	3.981
7.0	2.239	5.012
8.0	2.512	6.310
9.0	2.818	7.943
10	3.162	10.000
20	10.000	100.000
30	31.620	1000.000
40	100.000	10,000
50	316.200	100,000
60	1000.00	1,000,000
70	3,162.00	10,000,000
80	10,000	100,000,000

Table 1.

2 Meter HT Transmitter Output Power		
WATTS	dBm	dBW
4.00	36.0	6.0
3.90	35.9	5.9
3.65	35.6	5.6
3.18	35.0	5.0
3.03	34.8	4.8
2.52	34.0	4.0
1.00	30.0	0.0

Table 2.

Receiver Input Levels				
Microvolts*	dBm	dBW	dBµV	S-Units**
100	-67	-97	40	S-9
50	-73	-103	34	S-8
25	-79	-109	28	S-7
12	-85	-115	22	S-6
6	-91	-121	16	S-5
3	-97	-127	10	S-4
1.5	-103	-133	4	S-3
0.75	-109	-139	-2	S-2
0.38	-115	-145	-8	S-1

* Across 50 ohms
** When S-9 is 100 microvolts. When S-9 is 50 microvolts, deduct -6 dB from dBm and dBW figures and from dBµV figures.

Table 3.

2 Meter HT Example of Transmission Calculations		
HT Transmitter output power		36 dBm (4 watts)
Coaxial cable loss	(subtract)	1 dB
Added SWR loss	(subtract)	0.1 dB
Antenna gain	(add)	2.6 dB
Effective radiated power		37.5 dBm (5.6 watts)
Space transmission loss	(subtract)	116 dB
Signal level at distant receiving antenna		-78.6 dBm
Receiving antenna gain	(add)	0 dB
Coaxial cable loss	(subtract)	0.5 dB
Signal level at receiver input		-79 dBm (25 µV)

Table 4.

Determining Transmission Loss

The plane earth transmission loss between two 2 meter antennas increases 12 dB as distance is doubled. This means that at distance 2X, the signal is one fourth as strong as at distance X. If you know the ERP of your station and the S-meter reading at another station, you can determine the transmission loss.

If, for example, the ERP is 38.5 dBm and the S-meter at the distant receiver indicates S-9 (-67 dBm), the transmission loss will be 105.5 dB since the algebraic sum of 38.5 dBm and -67 dBm is equal to 105.5 dB. This information can be valuable when upgrading your antenna installation.

The basic way to determine the expected level of your signal at a distant receiver is as follows:

- Transmitter output power (dBm)
- Less coax attenuation (dB)
- Less added SWR loss (dB)
- Plus antenna gain (dB)
- Plus antenna height-gain (dB)
- Less transmission loss (dB)
- Plus receiving antenna gain (dB)
- Plus receiving antenna height gain (dB)
- Less coax line loss (dB)
- Received signal level (dBm)

Antenna Height Gain

If you triple your 2 meter antenna height from 20 to 60 feet, antenna height gain will be 10 dB. And if the antenna height gain at a distant station is also 10 dB, there will be a 20-dB improvement in communication between the two stations. But, it is difficult to list antenna height gain unless you use some standard. When you increase the height of your antenna, you can use the original height as the reference.

Table 4 is an example of transmission calculations. If your portable 2 meter rig puts out 4 watts and your antenna gain is 26 dB, coax loss is 1 dB, and ERP will be 5.6 watts. If the distant station has a 0 dB gain antenna and total coax loss is 0.6 dB, the space transmission loss will be 116 dB when the S-meter indicates S-7 (25 microvolts). If the S-meter indicates S-9 when input is 50 microvolts, it would indicate S-8 under the above conditions. RF

Activities Calendar

compiled by Joyce Sawtelle

Send your announcements to: Radio Fun Activities Calendar, 70 Route 202 N, Peterborough, NH 03458. We'll print as many as space allows, on a "first come-first listed" basis.

NOV 4

EUSTIS, FL The Lake County Hamfest and Electronic Expo will be held at Lake County Fairgrounds at State Rte. 44 and County Rd. 452, 9 AM-5 PM. VE Exams at 11:30 AM, walk-ins OK. ATV and Packet demos. Flea Market. Tailgating. Talk-in on 147.255 or 442.900. Make checks payable to *L.A.R.A.*, and send *c/o Tim Morrison, P.O. Box 881, Tavares FL 32778.* Oct. 14th is the reservation deadline.

MILWAUKEE, WI The Milwaukee Repeater Club will sponsor the 11th annual "Friendly Fest 95," 8 AM-1 PM at Waukesha County Expo Center "Forum," N1 W24848 Northview Rd. Setup at 6:30 AM-8 AM. Please call *Burt N9VBI, (414) 328-0535.* Send SASE with payment (before Oct. 15th) to *The Milwaukee Repeater Club, P.O. Box 2123, Milwaukee WI 53201.* Talk-in on 146.91(-) Rptr., and on 146.52 simplex. On-site VE Exams.

NOV 5

MELVILLE, NY "Ham Expo 95" will be hosted by the Radio Central ARC, 9 AM-4 PM at the Huntington Hilton Convention Center. Setup at 6 AM. VE Exams 1 PM-3 PM. Talk-in on 145.15/4Z. Call *Ron Katz WB2DVK, (516) 689-3279 days; Emil Tillona KD1F, (516) 696-0610 eves.*

SPECIAL EVENT STATIONS

OCT 29-NOV 19

MODBURY NORTH, AUSTRALIA The North East RC will operate VI5AGP for the 1995 Adelaide Grand Prix (for Formula 1 cars), and provide an award for Amateur Radio operators and Short Wave Listeners. VI5AGP will be active from 0000 hours Oct. 29th-2359 hours Nov. 19th, on HF and VHF. For an award, contact VI5AGP. SWLs need to send details of both sides of the contact heard. Send $5A or 3 IRCs, along with normal QSL info to *North East Radio Club, P.O. Box 36, Modbury North 5092, Australia.*

ALCATRAZ ISLAND The Sacramento ARC will operate W6AK from Alcatraz Prison on Alcatraz Island. Three transmitters will divide their time between 3.88, 7.290, and 14.280 MHz; and if 15 meters is open, will hang out at 21.300. Operation will be about 10 AM-3:30 PM PST. QSL with SASE to *SARC, Box 161903, Sacramento CA 95816.* RF

Radio Fun flea market

Turn your old ham and computer gear into cash now. Sure, you can wait for a hamfest to try and dump it, but you know you'll get a far more realistic price if you have it out where 100,000 active ham potential buyers can see it, rather than the few hundred local hams who come by a flea market table. Check your attic, garage, cellar, and closet shelves and get cash for your ham and computer gear before it's too old to sell. You know you're not going to use it again, so why leave it for your widow to throw out? That stuff isn't getting any younger!

The *Radio Fun Flea Market* costs you peanuts (almost)-comes to 25 cents a word for individual (noncommercial) ads, and 80 cents a word for commercial ads. Don't plan on telling a long story. Use abbreviations, cram it in. But be honest. There are plenty of hams who love to fix things, so if it doesn't work, say so.

Make your list, count the words, including your call, address and phone number. Include a check or your credit card number and expiration. If you're placing a commercial ad, include an additional phone number, separate from your ad.

This is a monthly magazine, not a daily newspaper, so figure a couple of months before the action starts; then be prepared. If you get too many calls, you priced it too low. If you don't get many calls, too high.

So get busy. Blow the dust off, check everything out, make sure it still works right, and maybe you can help make a ham newcomer or retired old-timer happy with that rig you're not using.

Send your ads and payment to Joyce Bocash, *Radio Fun Flea Market,* 70 Route 202N, Peterborough NH 03458 and *get set for the phone calls.*

MAHLON LOOMIS, INVENTOR OF RADIO; by Thomas Appleby, (Copyright 1967). Second printing available from **JOHAN K.V. SVANHOLM**, N3RF, **SVANHOLM RESEARCH LABORATORIES**, P.O. Box 81, Washington DC 20044. Please send $25.00 donation with $5.00 for S&H. RF445

PRINTED CIRCUIT BOARDS for projects in *73, Ham Radio, QST, ARRL Handbook.* List, SASE. **FAR CIRCUITS,** 18N640 Field Ct., Dundee IL 60118. RF595

WANTED: BUY & SELL All types of Electron Tubes. Call (612)429-9397, Fax (612)429-0292. **C & N ELECTRONICS,** Harold Bramstedt, 6104 Egg Lake Road, Hugo MN 55038. RF620

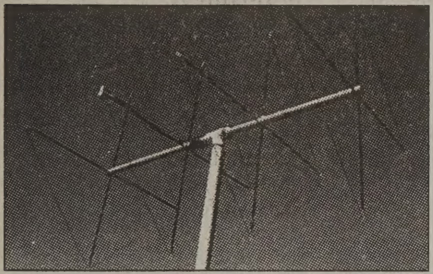
FREE HAM GOSPEL TRACTS, SASE, **N3FTT,** 5133 Gramercy,Clifton Heights PA 19018 RF960

Amateur Radio T-Shirts & Sweatshirts, Electronics Books. **Send for Catalogue.** Paul Washa 4916 Three Points Blvd. Mound MN. 55364-1245 RF995

KPC-3 TERMINAL PROGRAM User friendly, split screen, scrollback buffer, save & send files easily. User programmable auto connect. SASE for FREE details. $29.95.**ComTreK,** Box 4101, Concord NH 03302-4101. RF999

New Products

compiled by Victor Lapuszynski



CUBEX

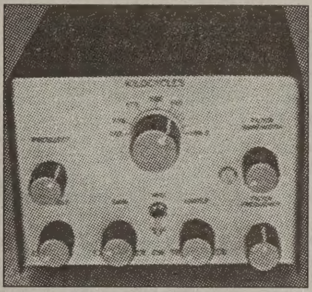
The Cubex Company announces its new "Yellowjacket" 2 meter four-element quad antenna. All Fiberglas construction and pretuned to provide less than 1.7:1 SWR across the 2 meter band, it needs no adjusting and the system is directly coax fed. The antenna can be rotated for quick horizontal or vertical polarization. and uses only a 42" boom. Components may be assembled in the field without tools, needing only a final twist with pliers to tighten the driven wire element. The best feature is the price: $34.95 fob Brea, CA, plus shipping and handling.

Cubex Company has been producing quality quad antennas for over 39 years.

For more information, contact: *Cubex Company, 2671 Saturn St., Unit E, Brea, CA 92621; (714) 577-9009, (714) 577-9124 (fax).* Or circle Reader Service No. 201.

RADIO WORKS

If you are a red- (or even a blue-) blooded ham, you are out there in the worst possible weather, putting up a new and improved antenna. How about an 80-page catalog of antenna goodies and accessories. Everything your little heart could desire! Drive yourself crazy with desire! For a free catalog, call Radio Works at (800) 280-8327, or (804) 484-0140, if you prefer to pay for the call yourself; fax is (804) 483-1873. The US Mule will get to them at *Radio Works, Box 6159, Portsmouth, VA 23703.* Or you could circle Reader Service No. 202.



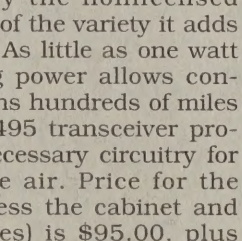
CURRY COMMUNICATIONS

Curry Communications introduces the CW495, a professional grade low frequency 1750 meter CW transceiver in a kit, for the enjoyment of license-free communications to enthusiasts without the usual expense. Low frequency communications at 1750 meters is a technical challenge and an opportunity to develop training and experience leading to an amateur radio license. Many amateur radio operators also enjoy the nonlicensed bands because of the variety it adds to their hobby. As little as one watt of transmitting power allows contact with stations hundreds of miles away. The CW495 transceiver provides all the necessary circuitry for success on the air. Price for the complete kit (less the cabinet and VFO accessories) is $95.00, plus shipping and handling.

Curry Communications manufactures low and medium frequency kits and equipment and provides consulting services to corporate and government clients. For more information, contact: *Curry Communications, 737 N. Fairview St., Burbank, CA 91505; (818) 846-0617.* Or circle Reader Service No. 203.

AZDEN

A new, unique voice-operated (VOX) switch model PTT-02 has been announced by the Communications Division of Azden Corporation, a manufacturer, distributor and dealer of Azden brand amateur and commercial radios and accessories. This device can give any radio the advantages of remote manual or voice-triggered transmission. Variable microphone gain, adjustable frequency equalization and VOX gain are included. It is usable with all types of microphones including dynamic and electret. A removable belt clip, Velcro tape, and a soft desk pad permit universal mounting. An OFF-PTT-VOX switch permits either normal push-to-talk or VOX operation. An adjustable (from 0 to +8 dB) 2-kHz gain control coupled with an overall gain control (0 to +10 dB) provides matching of most microphones to most radios as well as shaping the frequency response for improved DX operation. The unit measures 2.4W x .87H x 3.35D inches. A single 9-volt alkaline battery is used. The suggested price is $50.



For more information, contact: *Sid Wollin, Communications Division, Azden Corporation, 147 New Hyde Park Road, Franklin Square, NY 11010; (516) 328-7501, (516) 328-7506 (fax).* Or circle Reader Service No. 204.

SURPLUS TRADERS

SURPLUS TRADERS

Surplus Traders releases their new wall transformer and power supply catalog. They have 400,000 wall transformers in stock for immediate delivery, all cataloged by voltage, current, termination, polarity, color, etc. Surplus Traders specializes in the buying and selling of factory excess inventories of wall transformers and power supplies. In addition to the prices being extremely attractive, Surplus Traders can make immediate delivery of these devices when normal factory deliveries can take up to 14 weeks. In addition to the inventory on hand, they maintain a database listing thousands of units available in factory warehouses across North America. With over 400,000 units in stock and another 300,000 units being tracked, there is every likelihood that your requirements can be supplied. Everything is listed in the new catalog.

For more information, contact: *Marvin Birnbom, P.O. Box 276, Winter's Lane, Alburg, VT 05440; (514) 739-9328, (514) 345-8303 (fax).* Or circle Reader Service No. 205. RF

Uncle Wayne's Bookshelf

BOOKS FOR BEGINNERS

TAB4354 **The Beginner's Handbook of Amateur Radio, Third Edition** *by Clay Laster W5ZPV*, 395 pages. Wonderful book for newcomers. It is basic and well illustrated. Even if you have all the other ham handbooks, you'll still find this one useful. **$22.00**

W5GWNC **Technician Class License Manual: New No-Code** *by Gordon West* This book covers everything you need to become a Technician Class Ham. Every question and answer on the examinations is found in this one book. FCC Form 610 application. **$9.95**

AR4432 **W1FB's Help for New Hams** *by Doug DeMaw W1FB* Complete for the newcomer. Put together a station and get on the air. **$10.00**

AR4920 **Introduction to Radio Frequency Design** In this practical book, the author emphasizes use of models and their application to both linear and nonlinear circuits, reviews traditional material stressing the viewpoints taken by the RF designer and illustrates subject material by numerical examples. Includes 3 1/2 inch disk for IBM PC or compatibles. **$30.00**

SOFTWARE

GGTE Morse Tutor From beginner to Extra Class. Code from 1 to over 100 words per minute. Standard or Farnsworth mode. Create your own drills. Exams conform to FCC requirements. 5 1/4" floppy for IBM PC, XT, AT, PS/2 or compatibles.

GG52/5 Morse Tutor 5.25" Disk	**$19.50**
GG31/2 Morse Tutor 3.5" Disk	**$19.50**
GGADV5 Gold Edition 5.25" Disk	**$29.95**
GGADV3 Gold Edition 3.5" Disk	**$29.95**

W5GWHO Ham Operator Education Package Software, Novice—Extra for PC's, contains both 3 1/2" and 5 1/4" disks. **$39.95**

W5GWNSW No-Code Ham Radio Software Package for PC's, contains both 3 1/2" and 5 1/4" disks. **$29.95**

Lanze Code Programs—(Available on 5 1/4" disk.) Inexpensive complete study guide code programs for both the C64/128 Commodores and the IBM compatibles. Programs include updated FCC questions, formulas, schematic symbols, diagrams, and simulated (VE) sample test.

	IBM Part#	Commodore Part#	Price
Novice	LZIBM01	LZCOM01	**$14.95**
Tech	LZIBM02	N.A.**	**$14.95**
General	LZIBM03	N.A.**	**$14.95**
Advance	LZIBM04	N.A.**	**$19.95**
Extra	LZIBM05	LZCOM05	**$19.95**

* Add $2.00 for 3 1/2" disk. ** Not available

CODE TAPES

73T06 **"The Stickler"** **$5.95**

6+ wpm—This is the practice tape for the Novice and Technician licenses. It is comprised of one solid hour of code. Characters are set at 13 wpm and spaced at 5 wpm.

73T13 **"Back Breaker"** **$5.95**

13+ wpm—Code groups again, at a brisk 13+ wpm so you'll be really at ease when you sit down in front of a steely-eyed volunteer examiner who starts sending you plain language code at only 13 per.

73T20 **"Courageous"** **$5.95**

20+ wpm Congratulations! Okay, the challenge of code is what's gotten you this far, so don't quit now. Go for the Extra Class license. We send the code faster than 20 per.

73T25 **"The Mind Boggler"** **$5.95**

25+wpm Fiendishly generated by kindly old Uncle Wayne for hams with a strong need for self punishment. Once you've conquered 25 per let Unk know if you need a 50 wpm tape.

ARRL BOOKS

AR1995 **ARRL 1995 Handbook (71st Ed.)** Features: added DSP, improved treatment of Pi and Pi-L, all new all-digital-logic, plus lots more. **$30.00**

AR1086-4 **ARRL Operating Manual (4th Ed.)** Information on how to make the best use of your station, including: interfacing home computers, OSCAR, VHF-UHF. **$18.00**

AR3657 **QRP Notebook** *by Dave DeMaw W1FB* Presents construction projects for the QRP operator. **$10.00**

AR3207 **W1FB's Design Notebook** *by Dave DeMaw W1FB* Filled with simple practical projects that can be built using readily available components and common hand tools. **$10.00**

AR0402 **Solid State Design** Good, basic information, circuit designs and applications; descriptions of receivers, transmitters, power supplies, and test equipment. **$15.00**

AR4173 **Now You're Talking! All You Need To Get Your First Ham Radio License (2nd Edition)** A complete study guide for the Technician and Novice written exam. Practical information every beginner needs is written clearly and simply and in small doses. **$19.00**

AR4971 **ARRL Repeater Directory 1995-1996** 19,000+ listings with digipeaters, bandplans, CTCSS (PL(TM)) tone chart, frequency coordinators, ARRL special service clubs, and beacon listings from 14 MHz to 24 GHz. **$7.00**

AR3398 **The DXCC Companion** *by Jim Kearman KR1S* Spells out in simple, straightforward terms what you need to be a successful DXer. **$8.00**

AR1250 **Log Book**—Spiral **$3.50**

AR3177 **The ARRL Spread Spectrum Source Book.** From a deceptively simple beginning, a group of experimenters set out to develop first theoretical and later practical systems for spread spectrum communications. This book consists of articles, papers and government reports that document the process whereby amateur spread spectrum progressed from the drawing board to the airwaves. **$20.00**

AR3851 **Hints and Kinks** Ideas for setting up your gear for comfortable, efficient operation. **$10.00**

ARRL License Manuals Complete FCC question pools with answers.

AR4181 **Technician Class**	$ 6.00
AR4688 **General Class**	$12.00
AR3274 **Advanced Class**	$ 8.00
AR3282 **Extra Class**	$ 8.00

AR3185 **The Satellite Experimenter's Handbook, (2nd Ed.)** *by Martin Davidoff K2UBC* Expanded and revised. Focusing on satellites built by and for the international radio amateur community. **$20.00**

AR2030 **Your Gateway to Packet Radio (2nd Ed.)** Tells everything you need to know about this popular new mode. **$12.00**

AR4645 **Satellite Anthology** The latest information on OSCARs 9 through 13 as well as the RS satellites, the use of digital modes, tracking antennas, RUDAK, microcomputer, and more! **$10.00**

AR4483 **Weather Satellite Handbook (4th Ed.)** *by Dr. Ralph Taggart WA8DQT* Expanded and revised to reflect today's weather-fax satellite technology. **$20.00**

AR4653 **Companion Software for Weather Satellite Handbook** 5 1/4" MS-DOS Floppy. **$10.00**

AR2083 **Complete DX'er (2nd Ed.)** *by Bob Locker W9KI* Learn how to hunt DX and obtain hard-to-get QSL cards. **$12.00**

AR3762 **Your QRP Operating Companion** No special rigs or expensive equipment to enjoy the excitement and challenge of low-power operating. **$6.00**

AR3169 **QRP Classics** Compilation of ARRL publications on building receivers, transmitters, transceivers, accessories. **$12.00**

AR4270 **FCC Rule Book** A must for every active radio amateur. **$9.00**

AR0356 **Morse Code: The Essential Language** *by L. Peter Carron, Jr. W3DKV* Expanded and revised in its 2nd edition. How to handle distress calls heard not only on the hambands but on maritime and aircraft frequencies. **$6.00**

AR3983 **Understanding Basic Electronics** An ARRL book. 314 big pages. This explains everything very simply: the math, DC, AC, transistors, even tubes (wow!). Dirt cheap at $17. Isn't it about time you understood the fundamentals? **$17.00**

REFERENCE

RS-1 **The Amateur Radio Mail Order Catalog and Resource Directory, 4th Edition** is the most comprehensive source book for electronic parts, software, and equipment targeted at the radio amateur or serious electronic hobbyist anywhere! Plus a wealth of "value-added" reference material all in 262 pages. 4th Edition clearance at only **$8.95**. (was $16.00)

TAB2701 **Transmitter Hunting** *by Joseph Moell and Thomas Curlee* Radio direction finding simplified. **$19.95**

UE202 **RTTY Today** *by Dave Ingram* Modern guide to amateur radioteletype. **$8.95**

WGP87158 **1995 North American Callbook** The 1995 North American Callbook lists the calls, names, and address information for 500,000+ licensed radio amateurs in all countries of North America. **$35.00**

05H24 **Radio Handbook, 23rd Ed.** *by William I. Orr W6SAI* 840 pages of everything you wanted to know about radio communication. **$39.95**

WGP1234 **1995 International Callbook** The new 1995 International Callbook lists 500,000+ licensed radio amateurs in the countries outside North America. It covers South America, Europe, Africa, Asia, and the Pacific area (exclusive of Hawaii and the U.S. possessions). **$35.00**

W5GWNV **No-Code Video, Manual, Part 97 Rules** Learn how to be a ham radio operator. **$29.95**

AR4092 **Your RTTY/AMTOR Companion** invites you to explore the world of HF digital communications. If you've never operated RTTY or AMTOR before, this book is written expecially for you! You won't find complicated technical jargon here. Just information you can use right away. You'll discover how to . . . Assemble your own RTTY/AMTOR station . . . Use RTTY and AMTOR to talk to amateurs throughout the world . . . Compete in RTTY/AMTOR contests . . . Hunt for digital DX. **$8.00**

AR3754 **Radio Frequency Interference—How to find it and fix it.** Interference problems are challenging, but curable. With the techniques in this book, you can help restore electronic peace in your neighborhood. **$15.00**

20N096 **How To Read Schematics (4th Ed.)** *by Donald E. Herrington* Written for the beginner in electronics, but it also contains information valuable to the hobbyist and engineering technician. **$19.95**

TAB37109 **Secrets of RF Circuit Design** *by Joseph J. Carr* Written in clear non-technical language, covers everything from antennas to transistors. **$21.95**

TAB11065-1 **Mastering Radio Frequency Circuits** by Joe Carr, 411 p. If you're interested in learning about radio components and circuits, this book is great! Plus there are a ton of simple circuits you can build. It explains how circuits work, about test equipment, receivers, the works. This will take a lot of the mystery out of how radios work...the easy way. This will be one of your better $20 ham investments. **$20.00**

ANTENNAS

AR4114 **Low Profile Amateur Radio** For the Ham who lives where antennas are frowned upon. From hiding your antenna to operating with low power. This books tells you how to get on the air using these tehniques, and others,without calling attention to yourself. **$8.00**

UE220 **The Easy Wire Antenna Handbook** *by Dave Ingram K4TWJ.* All of the needed dimensions for a full range of easy to build and erect "sky wires." **$9.95**

TAB 3270P **Practical Antenna Handbook**—Second Edition, 1994, Joseph Carr; Tab Books. This 560-page book is a real treasure. Sarts with the fundamentals of antenna and feedline theory, explains about propagation of all kinds, and then provides a ton of easy antenna construction projects. Covers antennas and feeders for all bands. The explanations are simple and well illustrated, with some math, where it's unavoidable, but it won't bog you down. It even has the ZL-Special antenna, which I've used on 20m with some spectacular DXing success. A low angle of radiation and made it so I could always work the rare stuff first . . . Wayne. **$26.95.**

AR4734 **ARRL Antenna Book** The new 16th Edition represents the best and most highly regarded information on antenna fundamentals, transmission lines, design, and construction of wire antennas. **$30.00**

AR0194 **Antenna Compendium Vol. 1** Materials on verticals, quads, loops, yagis, reduced size antennas, baluns, Smith Charts, antenna polarization. **$10.00**

AR2545 **Antenna Compendium Vol. 2** Covers verticals, yagis, quads, multiband and broadband systems, antenna selection. **$12.00**

AR2626 **Companion Software for Antenna Compendium Vol. 2** 5 1/4" MS-DOS floppy. **$10.00**

AR4017 **Antenna Compendium Vol. 3** More verticals, yagis, quads, plus loops, arrays, mobile, direction finding, controlled currents, computerized, installation, overloads, plus 40 new articles for beginner's to advanced. **$14.00**

ARRL 4912 Antenna Compendium Vol. 4 You'll find 38 articles inside, covering a wide range of topics. There are simple, practical antenna projects, and there are heavy duty, theiretical treatments of complex arrays. Bundled inside is an IBM PC-compatible 3.5-inch, 720 kB disk. It contains executable programs and data. **$20.00**

AR4661 **Antennas and Techniques for Low-Band DXing** can be your ticket to low-band success. Drawing on the experiences of successful DXers and the author's own considerable experience, John Devoldere, ON4UN, shares the tips and techniques that can make the difference between a station that takes part in a contest and one that wins it! **$20.00**

AR3819 **Physical Design of Yagi Antennas** *by David B. Leeson W6QHS* provides the tools here to design and build robust Yagi antennas, using sound mechanical engineering principles. You need no longer fear the consequences of wind or ice storms on your antennas. With this information, you can build or "beef up" existing Yagis. **$20.00**

AR2618 **W1FB's Antenna Notebook** *by Dave DeMaw W1FB* Get the best performance out of unobtrusive wire antennas and verticals. Build tuners and SWR bridges. **$10.00**

AR2200 **Antenna Impedance Matching** *by Wilfred N. Caron* Most comprehensive book written on using Smith Charts in solving impedance matching problems. **$20.00**

AR0410 **Yagi Antenna Design** A *Ham Radio* series polished and expanded by Dr. Lawson. **$15.00**

WAYNE WRITES

WG1 **We The People *Declare War* On Our Lousy Government**—360p soft cover. This is Wayne's report explaining what the major problems are facing both New Hampshire and the country, and proposing simple, inexpensive solutions: a simple way to have government departments happily cut their expenses by 50% within three years; how to cut the cost of incarcerating prisoners by over 90%; how to end welfare; how to reduce the deficit; how to cut medical costs and improve health care; how to cut school costs and improve schools. An absolute steal at **$13.**

WG4 **20/20 Foresight**—Twenty 16p updates on the **Declare War** book—320p. Further proposals for solving critical American problems, such as a new approach to financing small businesses, how to finance Russia and other countries and make a profit doing it, the real dope on bioelectromagnetics, a new kind of polytechnical university, a new electronics technology, why Africa is in such a mess, why Perot bombed, how to have tuition-free universities, a plan for making Congress turn honest, etc. Plenty more. Ridiculously priced at **$10.**

WG5 **Submarine Life in WWII**—60p. Wayne's story of his adventures on the USS Drum SS-228 on five war patrols in the Pacific in 1943-45. What's it really like on a submarine when you're being depth charged? And what's the day-to-day life on a submarine like? Did you see the movie Das Boot? Exciting stuff and only **$7.50.**

WG6 **Uncle Wayne's Caribbean Adventures**—96p. Wayne's adventures scuba diving all around the Caribbean, visiting ham operators, and sightseeing. If you're interested in how to travel economically, you'll get some great ideas from this. He starts out with his "Diving, the Wimp Sport." You'll love the visits to 11 islands in 21 days trip. A measily **$7.50.**

WG7 **Uncle Wayne's Travels**—52p. Wayne travels to Russia, London, Aspen, St. Pierre, Munich, Vienna, Krakow, and Prague without it costing nearly as much as you might think. Cheap for you too, at **$5.00.**

WG9 **Wayne Talks: 'Dayton' 1995**-90 minute tape-What he would have said if he'd been asked to speak. **$5.00**

Uncle Wayne's Bookshelf Order Form

You may order by mail, telephone, or fax. All payments are to be in US funds. Allow 3 weeks for delivery. (Prices subject to change without notice if the suppliers increase our prices.)

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Signature ____________ Phone ____________

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